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## THE GENUS *PIPTATHERUM* (GRAMINEAE) IN SOUTHWEST ASIA

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**ABSTRACT.** A taxonomic revision is given of the grass genus *Piptatherum* P. Beauv. as it occurs between the east Mediterranean and the Himalayas. Twenty-two species are dealt with out of the generic total of twenty-five. Reasons are given for recognizing *Piptatherum* as a genus independent from *Oryzopsis* within which it has often been included. The characteristic features of *Piptatherum* are: spikelets, antheria and caryopses dorsally flattened; callus minute (up to 0.3 mm), generally incurved, glabrous, with the articulation scar transversely elliptic or circular and never grooved; awn neither twisted nor curved, usually caducous; lodicules 3, with the lower ovate and the upper dissimilar, never pilose; styles 2, distinctly separated at the apex of the ovary, never pilose. Keys are given to the species and infra-specific taxa, mainly using lemma and awn characters. Attention is drawn to the often characteristic ecological and altitudinal requirements of individual species. Several previously recognised species are reduced either to synonymy or to a lower rank; two new species, *P. flaccidum* Freitag from C and E Afghanistan and *P. baluchistanicum* Freitag from Pakistan and SE Afghanistan, are described. Infrageneric categories previously recognized but not formally described are validated. Distribution maps are given for all the species dealt with.

**ZUSAMMENFASSUNG.** Die Gräsergattung *Piptatherum* wird für den Bereich zwischen dem östlichen Mittelmeer und dem Himalaya revidiert, in dem 22 der insgesamt 25 (bzw. 26) Arten der Gattung vorkommen. Zunächst wird die Aufrechterhaltung der Gattung *Piptatherum* begründet, die bisher meist als Sektion von *Oryzopsis* geführt wurde. Charakteristische Merkmale von *Piptatherum* sind: Ährchen, Anthecien und Caryopsen vom Rücken her abgeflacht; Callus sehr kurz (bis 0.3 mm), meist ventral zur Vorspelze hin eingeschlagen, kahl, mit transversal-elliptischer oder kreisförmiger, nie längsfurchiger Narbe; Granne weder gedreht noch gekrümmt, gewöhnlich hinfällig; Lodiculae 3, die unten ovat, das obere meist linealisch, nie behaart; Griffel 2, an der Spitze des Ovars getrennt voneinander inseriert, kahl. Es folgt eine ausführliche Diskussion der für die Gliederung der Gattung benutzten Merkmale. Der Artenschlüssel basiert vor allem auf Merkmalen der Deckspelze und der Granne. Die Beschreibung der einzelnen Arten enthält u.a. Schlüssel zu den infra-spezifischen Taxa und Angaben zur oft charakteristischen Ökologie sowie zur vertikalen und horizontalen Verbreitung, die durch Punktkarten unterstützt werden. Eine größere Anzahl von Arten wird eingezogen oder zu infra-spezifischen Einheiten herabgestuft. Zwei neue Arten werden beschrieben: *P. flaccidum* Freitag aus C- und E-Afghanistan und *P. baluchistanicum* Freitag aus Pakistan und SE-Afghanistan.

### INTRODUCTION

With a revision of *Piptatherum* published by Roshevitz in 1951 and an account by Bor for *Flora Iranica* in 1970 (under *Oryzopsis*), the need for another treatment of the genus requires some justification. The author

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spent several years in Afghanistan studying ecology and plant communities (Freitag 1971 a, b) and it was soon obvious that species of *Piptatherum* (*Oryzopsis* auctt.) and *Stipa* formed very important components of the vegetation. Economically they are the most important ones especially in pastures of medium and high altitudes. Stimulated by the difficulties experienced in identifying the species and encouraged by their apparent strict ecological and geographical distributions, the author decided to undertake a new revision in the hope that his field knowledge would enable him to contribute much new information about this interesting genus.

A large number of specimens, and much data regarding their ecological requirements, were collected during the author's four years in Afghanistan. The final working-up of the material proved very time-consuming and extended far beyond the first intentions. Very useful help was given by the papers of Grigoriev (1938) and Roshevitz (1951) together with the treatments of the genus in Soviet Central Asiatic Floras (Ovchinnikov & Chukavina, 1957; Pazij, 1968), but these authors had seen no or very little material from Afghanistan which, in fact, is the area of greatest species diversity. The recent detailed *Flora Iranica* treatment of Bor (1970) unfortunately proved extremely confusing. So the only way to obtain reliable identifications was to see and to compare authentic material of all the species thought to occur in Afghanistan; this also meant considering all the species occurring in adjacent countries. In doing so, material from most larger herbaria was studied and, gradually, the work grew to a revision of the genus for the whole area between the E Mediterranean and the Himalayas, covering, but not maintaining, 26 of the 33 species mentioned in Roshevitz's revision.

Altogether about 1000 specimens were investigated but the coverage differed somewhat for different areas. For the *Flora Iranica* region almost all available material has been seen, but from Anatolia and Transcaucasia only a limited range; but in the latter regions, the genus does not pose much in the way of problems. As the species under discussion are dealt with in the literature under different generic names, e.g. *Piptatherum* P. Beauv. and *Oryzopsis* Michx., it is necessary to discuss now the position and interrelationships of these genera.

## HISTORY AND CHARACTERS OF THE GENUS

### NOMENCLATURAL HISTORY

The first two *Piptatherum* species were described by Linnaeus in 1753 as *Agrostis miliacea* and *A. paradoxa*. Only a few more species have since been described under that generic name. Later, in 1762, Linnaeus transferred his *Agrostis paradoxa* to the genus *Milium*, and he was followed by other authors describing new species of our genus or placing already known ones into *Milium*.

The genus *Piptatherum* was founded by Palisot de Beauvois in 1812 with the former species *Milium coerulescens*, *M. multiflorum*, *M. paradoxum* and *M. punctatum* (= *Eriochloa punctata* Desv.). His concept, however, was not generally accepted, although it was adopted by Boissier in *Flora Orientalis* (1884). Only in recent times has the name been revived by Roshevitz (1951) and followed by most Soviet authors. Trinius (1820) and Trinius & Ruprecht (1843) united the genera *Piptatherum* P. Beauv., *Oryzopsis* Michx., *Eriocoma*

Nutt., *Nasella* Desv. and *Piptochaetium* Desv. in the genus *Urachne* Trin., but their very wide generic concept was not accepted by other authors. Most agrostologists accepted the view of Bentham & Hooker (1883) and included the species of *Piptatherum* in *Oryzopsis* Michx. Even today most non-Soviet authors agree in that respect, including Pilger (1954), de Winter (1965) and Bor (1960, 1968, 1970).

#### DELIMITATION OF THE GENUS PIPTATHERUM

The contrasting views about the appropriate genus name have certainly been influenced by the fact that *Oryzopsis* was described from N America and *Piptatherum* from the Mediterranean, and only a few authorities had the opportunity or made use of investigating material from both areas. Even Palisot de Beauvois (1812), when he described *Piptatherum*, confessed that he had not seen *Oryzopsis*, which was founded by Michaux (1803) on *O. asperifolia*. He only knew the genus from the description by Michaux and placed the two genera close to each other and to *Achnatherum* and *Stipa*. Already in this context it should be mentioned, that Michaux cited only one *Oryzopsis* species. Another one, which only later was called *Oryzopsis*, was placed by him in the genus *Stipa* (*Stipa juncea* Michx. = *O. canadensis* (Poir.) Torr.), with the comment that it was close to *Avena sibirica* L. (= *Stipa sibirica* (L.) Lam.). Palisot de Beauvois said of *Oryzopsis* that it differed only in the united style from *Stipa* and therewith gave a clear hint on the affinities of that genus.

Boissier in *Flora Orientalis* mentioned in his description of *Piptatherum* some of its diagnostically more important characters: the dorsally compressed, biconvex spikelets, the very short callus, the convex-shaped lemma marginally covering the palea, the deciduous, erect and untwisted awn and the 2 short styles. Since only oriental grasses were dealt with, he did not mention *Oryzopsis*. Some of the differences between the two genera are illustrated in figs. 1 and 2.

Authors placing *Piptatherum* as a section in the genus *Oryzopsis*, such as Bentham & Hooker (1883), cited as the only differences the presence or absence of a ring of hairs at the callus and the eccentric or subcentral position of the awn. Also Roshevitz (1951), although referring to a thorough morphological investigation of both genera, only cites the callus hairs in favour of the recognition of *Piptatherum* as a separate genus. He did, however, see striking reasons for the separation of *Oryzopsis* and *Piptatherum* on account of their geographical segregation.

In the existing situation it therefore seemed essential to compare the studied *Piptatherum* species with *Oryzopsis asperifolia* Michx., the type species of the genus, with the other *Oryzopsis* species from N America and the numerous oriental species of *Stipa* s.l. The results, with regard to the most important differential characters are given in table 1. They indicate clearly, that a whole complex of characters separates *Piptatherum* from *Oryzopsis*. Although not many counts are known the chromosome number for *Piptatherum* is  $2n = 24$  (literature records from 5 species) as opposed to 46 and 48 in *O. asperifolia* (Johnson 1945, Bowden 1960) and the same number or 22 in the other 5 cytologically known N American species. Only in *O. pungens* have both  $2n = 22$  and 24 been counted (Bowden, 1960).

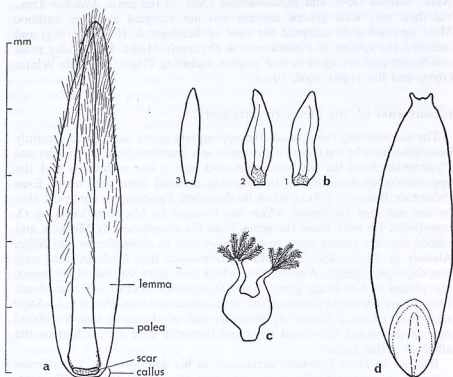


FIG. 1. *Piptatherum molinioides* Boiss.: a, anthercium; b, lodicules (1 & 2, lower lodicules; 3, upper lodicule); c, gynoecium; d, caryopsis. a-c, Kotschy 755a (type); d, Pabot 10068E.

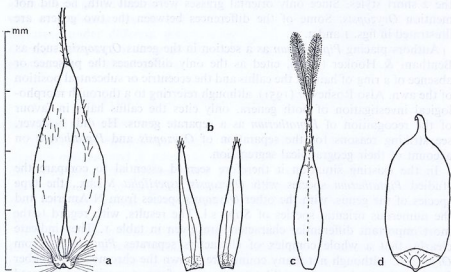


FIG. 2. *Oryzopsis asperifolia* Michx. and *O. racemosa* (J. E. Smith) Ricker: a, anthercium; b, lodicules; c, gynoecium; d, caryopsis. a, b & d, *O. asperifolia*, 1835, Copley-Greene; c, *O. racemosa*, Pearson s.n. (the gynoecium of *O. asperifolia* is similar, but the available material was more mature).



On the basis of all these facts it appears more justifiable to retain *Piptatherum* as a distinct genus, even if it seems impossible to separate the genera by anatomical criteria (Metcalf, 1960).

A diagnosis of the genus is as follows:

*Piptatherum* P. Beauv. Spikelets, antheia and caryopses dorsally flattened; callus minute (0.1 mm) to very short (up to 0.3 mm), mostly incurved, never bearded, with the outline of the articulation scar transversely elliptic, more rarely circular, and with the scar itself never deeply grooved; lemma only marginally covering the palea, with the awn inserted centrally, awn neither twisted nor curved; lodicules 3, with the lower ones ovate and the upper usually dissimilar, linear, never pilose; styles 2, inserted distantly at the apex of the ovary, never pilose, with relatively short stigmas.

A small group of species with *P. miliaceum*, *P. virescens* and *P. paradoxum* shows closer relations to *Oryzopsis* on account of their only subcompressed spikelets, lemmas and caryopses, somewhat longer (0.1–0.3 mm) conical callus and circular outline of the articulation scar. But as in overall structure they resemble much more closely the bulk of the typical *Piptatherum* species, they merit only separate sections. It has some significance that Palisot de Beauvois (1812) placed *P. miliaceum* under his genus *Achnatherum*, which is very close to *Oryzopsis*.

With regard to *Oryzopsis* it is evident from table 1, that it shares almost all characters with the sections *Achnatherum* and *Ptilagrostis* of *Stipa*. The resulting problems of delimitation between *Oryzopsis*, *Achnatherum*, *Ptilagrostis* and *Stipa* will be tackled in a future paper in which I hope to deal with the oriental species of *Stipa* s.l.

Although excluded from the Stipeae by most modern authors, the genus *Milium* has much in common with *Piptatherum*, especially in the dorsally compressed coriaceous lemma embracing the palea marginally, the minute callus, the shape and surface of the articulation scar and the insertion and shape of the styles. Most striking is the similarity with *P. miliaceum*, which also has the same short hilum as the *Milium* species. But as *Milium* differs in the absence of an awn, 2 lodicules only and larger chromosomes the separation of both genera seems to be well founded.

#### ASSESSMENT OF CHARACTERS

The main obstacle in working with *Piptatherum* is the notorious poverty of differential characters and the comparatively high degree of variability, both genetically and environmentally controlled. During the very first steps of the work in trying to identify the species by use of the available keys, the author learned that some of the traditional characters, such as the size of plants, spikelets, lemmas and the diameter of the panicle, just do not work, at least in certain cases. The suspicion grew that some species founded on such characters are mere forms or variants. In order to overcome the serious difficulties in delimitation and keying out of the species several approaches were undertaken.

1. First of all a search was made for more reliable, hitherto neglected, qualitative characters. Those found which appear to be useful are: the shape of the lemma; the occurrence of apical lemma lobes; the type and distribution of lemma indumentum; and the insertion of the awn.

TABLE I

Differential characters of *Piptatherum*, *Oryzopsis* and *Stipa* s.l. In *Piptatherum* and *Stipa* all SW Asiatic species were considered

Character	<i>Piptatherum</i> (22 species)	<i>Oryzopsis</i> <i>asperifolia</i> Michx.	<i>Stipa</i> sect. <i>Achnatherum</i> & <i>Ptilagrostis</i> (11 spec.)	<i>Stipa</i> sect. <i>Stipa</i> (34 species)
Spikelet; shape	dorsally compressed or subcompressed	laterally subcompressed	laterally subcompressed	laterally subcompressed
Anthercium (lemma & palea & callus)	dorsally compressed or subcompressed	cylindrical	cylindrical to laterally subcompressed	cylindrical to laterally subcompressed
Callus; shape	minute and without distinct shape, rarely conical	conical	conical	cylindrical
; direction	curved inwards, rarely straight	straight	straight or oblique (outwards)	oblique (outwards)
; length, in mm	0·1 rarely up to 0·3	0·3	0·3-0·5(-0·7)	(0·5-)1-5
; indumentum	glabrous	densely bearded	densely bearded	densely bearded
; base in outline	rounded	rounded	rounded	acute
; articulation scar in outline	transversely elliptic, rarely circular	longitudinally elliptic	longitudinally elliptic	longitudinally elliptic
; art. scar, surface	almost flat	deeply grooved	deeply grooved	deeply hollowed
Lemma; as covering palea	marginally	completely	marginally to completely	completely
Arista; durability	fine, caducous, rarely persistent	strong, persistent	fine to strong, caducous or persistent	fine or strong, persistent
; shape	straight, erect	twisted, curved	twisted, curved or geniculate	twisted, geniculate
; length, in mm	0·1-1·5	5-10	(7-)10-40(-80)	(1·5-)40-500
Lodicules; number	3	2	3	2 or 3
; shape	lower ones ovate, upper narrower (linear)	linear	linear or oblong	linear
; indumentum	absent	present	absent	absent or present
Ovary	ovate to obovate	cylindrical	ovate to obovate	ovate to cylindrical
Styles; number and shape	2, short, bent outwards	1, long	2, rather short, bent outwards or parallel	2, short or long, parallel
; insertion	distant from each other	terminal	close to each other	close to each other
Chromosome number	24 (5 spec.)	46 or 48	(24)28 or 48 (4 spec.)	28, 32, 36, 44 (13 spec.)

2. In view of the limited number of qualitative characters it was also necessary to make use of quantitative criteria. For this purpose intra-specific variability was checked first. A few species with unique qualitative characters were used as a standard, especially *P. barbellatum*.
3. The results of critical examinations were compared and cross-checked with similar approaches undertaken simultaneously in the genus *Stipa* s.l. for the same area.
4. All available geographical and ecological data were used for verification. Very rare species, reported from a few localities or only once, were suspected, *a priori*, to be forms of more widely distributed species, and that assumption, in some cases, but not in all, proved to be correct. On the other hand, specimens assigned to disjunct species were carefully re-examined in case they belonged to different species. The author's own ecological experience of most of the species in the field gave extremely useful hints about the grouping of the lesser known or unknown taxa.

For the construction of the keys only such characters were selected that are easily observed, for the most part, and are not or only slightly influenced by environmental factors. Essentially these characters are linked with the lemma in the fruiting stage. If the material has not yet flowered, identification is difficult but is still possible. Determination of sterile tufts is impossible in some of the narrow-leaved species but detailed anatomical investigations may close that gap in the future.

**GROWTH FORM AND BRANCHING.** Growth form and mode of branching are almost stable in each species. One group of species grows as caespitose perennials forming small but very dense tufts as a result of much intravaginal branching. Each tuft consists of a high number of vegetative shoots and only a few culms. The culms are erect from a usually somewhat curved base. Almost procumbent culms occur as the regular type only in *P. rechingeri*, but as a result of heavy grazing they have been observed in dwarf individuals of most medium-sized species in the field as well as in herbarium material. Elongated basal internodes occur occasionally in plants growing on unstable slopes when they have been buried by thin layers of sliding soil or debris. This phenomenon, which looks rather like true extravaginal branching, is difficult to determine in herbarium material but it has been observed several times in the field, especially in *P. laterale* and *P. barbellatum*.

Species with regular extravaginal branching include most of the tall-growing species. Most of them also form tufts, but generally looser ones, and the number of vegetative shoots compared to the culms is smaller. In some cases vegetative shoots are absent, as is always the case in *P. latifolium* and usually in *P. miliaceum*.

In some tall-growing species, like *P. blanchetianum*, *P. coerulescens* and *P. holciforme*, both forms of branching—intra- and extravaginal—may occur.

The type of branching evidently has some ecological significance. Extravaginal branching occurs in those species completing their annual life cycle under favourable conditions; they may either grow in forests or meadows with sufficient water supply during the whole growing season, or as lowland species during the rainy spring season only. Intravaginal branching occurs in species from regions with a very short growing season (all alpine species belong to that group) or in those where the growing season, by reason of

temperature, is restricted to the dry season. This supports the conclusions of Serebrjakova (1971) about the evolution of growth forms in the grass family.

**SIZE AND STRUCTURE OF CULMS.** Individual species differ remarkably in their average size, and according to their height two groups can be recognized:

- a. tall-growing species, usually 50–100 cm, generally from lower altitudes, such as *P. aequiglume*, *P. blanchetianum*, *P. coerulescens*, *P. holciforme*, *P. latifolium*, *P. miliaceum*, *P. munroi*, *P. vicarium* and *P. virescens*.
- b. medium-sized species, usually 30–50 cm, generally from higher altitudes, including all the remaining species except *P. angustifolium*, *P. flaccidum* and *P. songoricum* which are transitional between the two groups.

As a result of grazing and because of different supplies of water and nutrients the range of variation is extremely wide, as may be seen from table 2.

TABLE 2

Size of flowering and fruiting culms, in cm, in two tall-growing and two medium-sized *Piptatherum* species

	No. of sheets examined	min.	mean range	max.
<i>P. holciforme</i>	73	30	60–100	130
<i>P. munroi</i>	23	30	50–90	120
<i>P. laterale</i>	157	12	25–50	80
<i>P. barbellatum</i>	25	10	25–50	60

The number of nodes is intimately correlated with the height of the plants and varies from about 2–4 in the medium-sized and 4–6 in the tall-growing species. The internodes are terete, striate and usually smooth and glabrous. Sometimes they are scaberulous with short prickles and in a few cases (*P. flaccidum*) may be covered below the nodes with a dense indumentum of short retrorse hairs. Because in other respects, plants with hairy internodes (and leaves) do not differ from typical glabrous ones and intermediate forms have been observed, they have been given only varietal rank.

#### LEAF CHARACTERS.

**Sheath.** With few exceptions leaf sheath characters are of little importance. In *P. virescens*, however, (and in *P. paradoxum* from outside our area) the distinctly ciliate sheath margins and the beard at the junction with the blade are characteristic. The sheaths are always striate, and their surface is either smooth, scaberulous or scabrous, but sometimes all three types can be found in one individual. A distinct pubescence occurs very rarely (*P. flaccidum*) and is associated with a similar indumentum on the culm internodes (see above). Certain differences do exist in the durability and structure of the dead sheaths but as these also depend on the substrate (in sands the sheaths persist much longer than in nearby loamy soil) no emphasis has been given to them. In some species the sheaths are eventually purplish coloured, especially in *P. coerulescens*, *P. molinioides* and *P. virescens*; occasionally too in other species.

*Ligule*. The shape and size of the ligules are likewise of limited use in distinguishing species. Three types have been observed:

- extremely short, almost absent (up to 0.3 mm at most) in *P. virescens*;
- short and truncate, 0.5–1.5 mm in *P. miliaceum*;
- longer with various outlines in all other species.

The degree of variation in the ligule characters is very high in the third group, even if the ligules of the culms and of the vegetative shoots are considered separately as is shown in table 3.

TABLE 3  
Ligule size, in mm, in some *Piptatherum* species

	No. of sheets examined	culm leaves			leaves of veget. shoots		
		min.	mean range	max.	min.	mean range	max.
<i>P. barbellatum</i>	25	1.5	2.4	8	1	1.5–2.5	3
<i>P. gracile</i>	42	2.0	3.6	10	1	2.0–4.0	5
<i>P. vicarium</i>	35	2.0	5.8	12	1	2.0–4.0	5

Very often on the same plant the ligules may be partly acute or obtuse. Usually they are lacerated from the upper margin, slightly scabrous on the back and at the base they fuse with the likewise hyaline margins of the sheaths.

*Blade*. Blade dimensions, especially width, are helpful in some cases. They are closely linked with growth forms, in as much as species with extravaginal branching and with few or no vegetative shoots have larger leaves than those with intravaginal branching. When both vegetative and generative shoots are produced, then the culm leaves are always wider and mostly shorter than the leaves of the vegetative shoots. But as the height of the individuals is strongly influenced by environmental factors so also are width and length of the leaves (see table 4).

The surface of the upper side is always furrowed longitudinally between the veins and in the xerophytic species rather deeply so. Beneath, the surface is flatter with shallow furrows and few prominent main nerves. The number of main and of lateral veins is specifically different in some cases, but has not been generally investigated. The upper surface of the blade in most species is covered by an indumentum located on the numerous ridges above the veins. The narrow-leaved species normally have an indumentum of short, rather stiff hairs. The leaves of the tall-growing species are in most cases

TABLE 4  
Width of leaf blades, in mm, in some *Piptatherum* species

	No. of sheets examined	culm leaves			leaves of veget. shoots		
		min.	mean range	max.	min.	mean range	max.
<i>P. laterale</i>	157	1.0	1.5–2.0	3.0	0.8	1.0–2.0	2.5
<i>P. gracile</i>	42	1.0	1.2–2.0	2.5	0.7	1.0–1.5	2.0
<i>P. flaccidum</i>	49	1.3	1.5–2.0	3.0	1.0	1.2–2.0	2.5
<i>P. latifolium</i>	5	6.0	8.0–13.0	15.0	—	—	—

only scabrous or scaberulous. Beneath, the leaves are either completely smooth, scaberulous or scabrous with the asperities located in the shallow furrows and directed towards the apex where they are usually longer and denser. True pubescence is very rare. The margins are invariably very rough



with apically directed prickles. Differences in the nature of the indumentum have only been used in a few cases as additional characters for specific delimitation.

**PANICLE.** Panicle characters have a certain reliability but less than credited by earlier authors. Consequently, with a few exceptions, they have not been used in the keys. In panicle *size*, the tall-growing species differ from the medium-sized ones, although modifying external factors cause some overlapping. The *shape* is well fixed in some species. For instance the following species have lax inflorescences with rather long, spreading branches: *P. aequiglume*, *P. angustifolium*, *P. blanchetianum*, *P. coerulescens*, *P. holciforme*, *P. miliaceum*, *P. munroi*, *P. songoricum*, *P. vicarium* and *P. virescens*. Most of the remaining species have ascending or erect branches and therefore narrower, sometimes spike-like panicles. Unfortunately even in species with normally spike-like panicles certain individuals of coherent populations produce lax panicles with spreading branches, as in *P. barbellatum* (plate 4). Finally, in certain species, e.g. *P. hilariae*, the shape of the panicle undergoes considerable changes in ontogeny: contracted before flowering, effuse at flowering and again contracted at fruiting. The ratio of the length of the longest branch to the length of the panicle proved rather stable and useful in delimitation of certain species, as for instance *P. holciforme* and *P. laterale*.

The *number of branches* united at the lower nodes of the panicle varies between 1 and 2, and in luxuriant individuals may go up to 4. Only in *P. miliaceum* is it usually 3-5. In certain taxa, multiplication of branches has been reported in literature and observed in investigated material. By earlier taxonomists they were given specific rank, as in *P. thomasi* (Duby) Kunth from Corsica and *P. sinense* Mez (= *Oryzopsis multiradiata* Hand.-Mazz.) from China, despite striking affinities to *P. miliaceum* in the first and to *P. aequiglume* in the second taxon. Later on, the systematic value of this verticillate arrangement has either been completely denied, as by Briquet (1910) for *P. thomasi* and Roshevitz (1951) for *P. sinense*, or else rated low, as by most authors for *P. thomasi*, citing it as a variety of *P. miliaceum*. My own observations led me to the opinion that giving *specific* rank to such taxa is unwarranted. But from the abundant material which has been seen, the conclusion can be drawn that such branching is probably genetically controlled. Because verticillate branching may be correlated with differences in distribution patterns, ecological behaviour and with other morphological characters, the respective taxa have been dealt with as subspecies (see *P. miliaceum* and *P. laterale*).

The *solidity* of the main axis and of the branches is another rather stable character. Stems may be thin and slender, occasionally even flexuous and flaccid as in the new species *P. flaccidum*, or rather stout and straight. The occurrence of tooth-like hairs on pedicels and branches, directed towards the spikelets and eventually causing a rough surface, was found to be an unreliable taxonomic character.

**SPIKELET.** The *size* of the spikelet comes into the category of an important differential character, but variation is considerable and generally has a range of about 70-120%. Some examples are given in table 5.

TABLE 5

Length of spikelets and lemmas, in mm, in some *Piptatherum* species

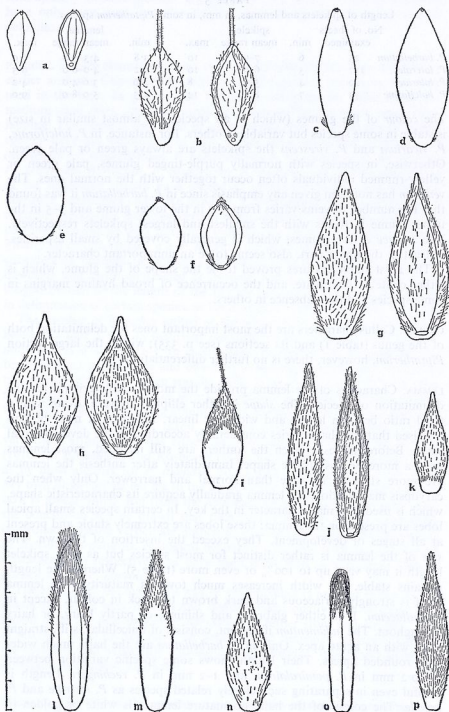
	No. of sheets examined	spikelets			lemmas		
		min.	mean range	max.	min.	mean range	max.
<i>P. barbellatum</i>	25	6	7-9	10	3.8	4.3-5.0	6.0
<i>P. laterale</i>	157	5	6-9	10	3.2	4.0-6.0	6.5
<i>P. hilariae</i>	40	4	5-7	8	2.6	3.0-4.0	4.2
<i>P. holciforme</i>	73	7	8-13	14	4.5	5.0-8.0	9.0

The colour of the glumes (which in all species are almost similar in size) is stable in some species but variable in others. For instance, in *P. holciforme*, *P. vicarium* and *P. virescens* the spikelets are always green or pale green. Otherwise, in species with normally purple-tinged glumes, pale green or yellow-rimmed individuals often occur together with the normal ones. The venation has not been given any emphasis since in *P. barbellatum* it was found that the number of veins varies from 3-7 in the lower glume and 3-5 in the upper glume in forms with the smallest and largest spikelets respectively. The surface of the glumes, which is generally covered by small asperities, at least in the upper part, also seems to be an unimportant character.

The most stable features proved to be the shape of the glume, which is either ovate or lanceolate, and the occurrence of broad hyaline margins in some species and their absence in others.

**CALLUS.** Callus characters are the most important ones for delimitation both of the genus (table 1) and its sections (see p. 335); within the large section *Piptatherum*, however, there is no further differentiation.

**LEMMA.** Characters of the lemma provide the most reliable criteria for the delimitation of species. The shape is either elliptic, obovate, ovate with a fixed ratio between length and width, or linear. However, it must be emphasised that the shape varies considerably according to the developmental stage. Before anthesis, when the anthers are still included, most lemmas have a more or less elliptic shape. Immediately after anthesis the lemmas are more strongly involute than normal and narrower. Only when the caryopsis matures does the lemma gradually acquire its characteristic shape, which is used as a main character in the key. In certain species small apical lobes are present on the lemma; these lobes are extremely stable and present at all stages of development. They exceed the insertion of the awn. The size of the lemma is rather distinct for most species but as with spikelet length it may vary up to 100% or even more (table 5). Whereas the length remains stable, the width increases much towards maturity. The lemma itself is strongly coriaceous and dark brown to black in colour, except in *P. miliaceum*. It is either glabrous and shining, or partly hairy, or hairy throughout. The indumentum if present, consists of unicellular, stiff, straight hairs with an acute apex. Only in *P. barbellatum* are the hairs much wider with rounded apices. Their length shows some specific variation between 0.1-0.2 mm in *P. pamiralaicum* and 1-2 mm in *P. rechingeri*. Length is helpful even in separating such closely related species as *P. laterale* and *P. gracile*. The colour of the hairs on mature lemmas is white or golden to brownish. Usually they are loosely appressed at the lemma to slightly ascending, but distinctly ascending at least near the apex. Only in a few



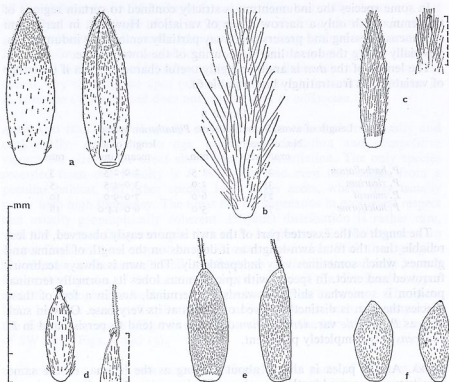


FIG. 4. Anthercia of *Piptatherum* species: a, *P. platyanthum* (Wendelbo 1225, sp. no. 17); b, *P. rechingeri* (Freitag 1533, sp. no. 18); c, *P. gracile* (Stewart 21885, sp. no. 19); d, *P. hilariae* (Rechinger 32246, sp. no. 20); e, *P. purpurascens* (Breckle 1541, sp. no. 21); f, *P. pamiralaicum* (Anders 7899, sp. no. 22).

species are they completely and densely appressed. In most species, even with otherwise glabrous lemmas like *P. blancheanum*, *P. coerulescens* and *P. vicarium*, two basal tufts of spreading hairs originate laterally to ventrally near the junction of the lemma with the callus. Some species exclusively have glabrous lemmas. However, in certain species with hairy lemmas occasional individuals with glabrous lemmas have been observed, as in *P. holciforme* and *P. platyanthum*; the reverse condition has been found in *P. angustifolium*. As they occur only sporadically in normal populations and are geographically distant from each other, varietal rank has been given to them.

FIG. 3. Anthercia of *Piptatherum* species: a, *P. miliaceum* (Gaillardot—Saida, sp. no. 1), b, *P. virescens* (Schulz 144—Jugoslavia, sp. no. 2); c, *P. coerulescens* (Bornmüller 10132; sp. no. 3); d, *P. blancheanum* (Gaillardot—Saida, sp. no. 4); e, *P. vicarium* (Tuturin & Besedin 81—type, sp. no. 5); f, *P. angustifolium* (Aitchison 527—type, sp. no. 6); g, *P. holciforme* ssp. *longiglume* (Bornmüller 12928, sp. no. 7b); h, *P. latifolium* (Hedge & Wendelbo 9290, sp. no. 8); i, *P. songoricum* (Rechinger 5059, sp. no. 9); j, *P. aequiglume* (Thomson—Simla, sp. no. 10); k, *P. munroi* (Freitag 5912, sp. no. 11); l, *P. molinioides* (Kotschy 755a—type, sp. no. 12); m, *P. flaccidum* (Griffith 102, sp. no. 13); n, *P. baluchistanicum* (Lace 3780—type, sp. no. 14); o, *P. barbellatum* (Griffith 131—type, sp. no. 15); p, *P. laterale* (Aitchison 947—type, sp. no. 16).

In some species the indumentum is strictly confined to certain regions of the lemma with only a narrow range of variation. However, in herbarium specimens, pressing and preservation may partially remove the indumentum, especially along the dorsal line by scouring of the lower glume.

The length of the *awn* is another highly useful character, even if the range of variability is frustratingly broad (table 6).

TABLE 6  
Length of awns, in mm, in some *Piptatherum* species

	No. of sheets examined	min.	length of awn	
			mean range	max.
<i>P. barbellatum</i>	25	1.5	2.0-2.5	3
<i>P. vicarium</i>	35	2.0	3.0-4.5	5
<i>P. munroi</i>	23	6.0	7.0-9.0	10
<i>P. holciforme</i>	73	5.0	6.0-14.0	18

The length of the exerted part of the awn is more easily observed, but less reliable than the total awn-length as it depends on the length of lemma and glumes, which sometimes vary independently. The awn is always scabrous, furrowed and erect. In species with apical lemma lobes its normally terminal position is somewhat shifted towards sub-terminal, and in a few of these species the awn is distinctly curved outwards at its very base. Only in such taxa as *P. laterale* var. *verticillatum* does the awn tend to persist, and in *P. virescens* it is completely persistent.

**PALEA.** As the palea is always about as long as the lemma, of the same structure and covered by the same type of indumentum, it has been neglected in descriptions. The apex of the palea is acute in all species except *P. miliaceum* where it is obtuse and distinctly emarginate.

**LODICULES.** The number of lodicules is invariably 3, with the 2 lower ones ovate and the upper usually narrower and almost linear. In length they do not vary much from one species to another, but in width all gradations occur. The lower lodicules are entire with a more or less acute apex and only in *P. virescens* are the margins slightly crenate near the tip. The apex of the upper lodicule is obtuse to truncate. In *P. virescens*, where it is unusually long, the apex shows surprising variability from rounded to bi- and tri-dentate.

**STAMENS.** Depending on the size of the spikelet the anthers vary greatly in length. Changes between yellow and purplish colours follow the same insignificant pattern as in the glumes. Some species always carry two tufts of stiff hairs on the apex of each anther, and this may be a help in distinguishing certain species related to each other. In certain species of broader distribution, most striking in *P. holciforme*, forms with and without bearded anthers have been seen.

**OVARY AND CARYOPSIS.** While the ovaries with styles and stigmas in all species look very similar, the caryopses differ in shape (which may be ovoid, obovoid or cylindric, and always somewhat flattened), in size and in the relative length of the hilum and the embryo (scutellum). The relative length



of the embryo (ratio of embryo to caryopsis) is normally about 1:3, but depending on the shape of the caryopsis it varies from about 1:2 in short-grained species like *P. pamiralaicum*, to 1:4 in long-grained species such as *P. aequiglume*, *P. laterale* and others. The relative length of the hilum is expressed in the ratio of hilum to caryopsis. The linear hilum in most species comes very close to the apex (about 9:10 or more), is distinctly shorter in *P. virescens* (3:4-4:5) and does not reach 1:2 in *P. miliaceum*.

**AREA AND ECOLOGY.** All species are well circumscribed chorologically and ecologically. According to age, ecological adaptation and competitive vigour, the size of the areas shows much differentiation. The only species recorded from one locality is *P. rechingeri* and even that comes from a peculiar habitat. All other species have larger areas, where they usually occur with high frequency. The areas are homogeneous in ecological respect and usually geographically coherent. Disjunct distribution is rather rare, with the most striking example that of *P. holciforme*: E Mediterranean to Kopet Dagh with an outpost in the Karatau mountains. With their geographical patterns the areas fit well into the types of distribution already known from other species of the area. A synoptic survey of the distribution types and the ecological behaviour of all species is given in table 7. The clear links between species distribution and altitude can be seen by comparing the distribution maps (Figs. 6-12 and 14-18) with the two altitudinal maps of SW Asia (Figs. 5 and 13).

**HYBRIDISATION AND INTROGRESSION.** Although most parts of the area have some sympatric species, hybridisation seems to be astonishingly rare. Only a few clear intermediates evidently caused by hybridisation have been seen: for instance, between *P. laterale* and *P. flaccidum*; *P. laterale* and *P. barbellatum*; and between *P. coerulescens* and *P. holciforme*. Introgression seems to play its obscuring part in such regions where the areas of closely related species touch each other. In this way the longer awns of some of the westernmost *P. laterale* populations may be caused by the influence of *P. holciforme*. Similar effects of introgression, and more difficult to unravel, probably occur in the east, where *P. laterale* and *P. gracile* meet.

#### INFRAGENERIC GROUPING

In order to express the relationships between the different species and groups of species the genus has been subdivided into 3 sections, and the largest of them again into 3 subsections, partly with informal species-groups. The first attempt to subdivide the genus was made by Boissier (1884), who split the *Piptatherum* species known to him into two groups: those with obovate to ovate lemmas and those with lanceolate lemmas. Later on Roshevitz (1951) recognized 3 sections on the basis of rather diverse characters, and his subdivision has been confirmed by the present work. In validating the sections, described by Roshevitz only in Russian, emphasis has been given to the most relevant characters only, which, at that level, are the shape of the callus, the shape of the articulation scar and the ratio hilum: caryopsis (see above). Roshevitz's further partition of the largest section into four series—*Coerulescentia*, *Euholciformia*, *Molinioidea* and *Himalayana*

—is less satisfactory, but is the nucleus of the classification accepted here. The shape of the lemma and the type of lemma indumentum are most significant qualitative characters which have been used for the creation of 3 subsections. In the largest subsection the species have been arranged in 3 informal species-groups, with 2 of them almost certainly representing true series. The anthecia of all the species dealt with in this paper are illustrated in figs. 3 and 4.

In evolutionary terms the sections and even the subsections have certainly followed different lines for a very long time. The species closest to ancestral forms is probably *P. miliaceum* in which the lemma and palea are not coriaceous and the callus not yet incurved. Other more primitive characters are the extravaginal branching and the loose panicles with numerous spikelets; characters found in all species of the subtropical lowlands, both in arid and humid climates. The sections *Miliacea* and *Virescentia* consist exclusively of such types. In the large section *Piptatherum* they are still present in all suitable habitats from Macaronesia to China, and they dominate in the geographically most widespread subsection *Coerulescentia*. Adaptation to cooler environments and invasion into the montane and alpine areas of the Irano-Turanian region and the Himalayas evidently took place from several stocks, but most successfully in subsection *Holciformia*. In that subsection active speciation appears to be still continuing, as is suggested by the pronounced polymorphism of certain species and the geographical patterns of the respective populations, as for instance in *P. laterale*, *P. flaccidum* and *P. hilariae*.

#### SYNOPSIS OF THE GENUS PIPTATHERUM

##### I. Sect. *Miliacea*

1. *P. miliaceum* (L.) Coss.
  - a. subsp. *miliaceum*
  - b. subsp. *thomasi* (Duby) Boiss.

##### II. Sect. *Virescentia*

2. *P. virescens* (Trin.) Boiss.  
[*P. paradoxum* (L.) P. Beauv., W Mediterranean only]

##### III. Sect. *Piptatherum*

###### A. Subsect. *Coerulescentia*

3. *P. coerulescens* (Desf.) P. Beauv.
4. *P. blanchetianum* [Desv. ex] Boiss.  
[*P. obtusum* (Hook.f.) Roshev., China only]
5. *P. vicarium* (Grig.) Roshev.
6. *P. angustifolium* [Munro ex] Boiss.

###### B. Subsect. *Holciformia*

###### Species-group 1 ('Ovata')

7. *P. holciforme* (M. Bieb.) Roem. & Schult.
  - a. subsp. *holciforme*
  - b. subsp. *longiglume* Hausskn.

8. *P. latifolium* (Roshev.) Nevski
9. *P. songoricum* (Trin.) Roshev.

###### Species-group 2 ('Lanceolata')

10. *P. dequighume* (Hook. f.) Roshev.

TABLE 7

Distribution types and ecological characteristics of the investigated *Piptatherum* species

Distribution type	Altitudinal belt	Species	Climatic character	Vegetation types
<i>Mediterranean species</i>				
almost omnimediterr.	colline	<i>P. coerulescens</i>	semihumid-semiarid	open evergreen forests, woodlands, seral vegetation
E Med.	"	<i>P. blancheanum</i>	"	" " " " " "
omni- to S Med.	"	<i>P. miliaceum</i>	semihumid-semiarid-arid	wadi beds, unstable habitats
<i>Submediterranean</i>				
E submed.	med.-montane to submed.-colline	<i>P. holciforme</i>	semihumid-semiarid	deciduous woodlands ( <i>Quercus</i> ), open seral vegetation
"	"	<i>P. virescens</i>	humid-semihumid	deciduous forests
<i>Irano-turanian*</i>				
Turkmen.-Tianshan.	coll. to submontane	<i>P. latifolium</i>	semiarid	deciduous woodlands ( <i>Pistacia vera</i> )
"	coll. to montane	<i>P. vicarium</i>	semiarid-arid	open deciduous woodlands, semidesert, seral vegetation
"	"	<i>P. songoricum</i>	arid	semideserts
Iranian	montane	<i>P. molinioides</i>	semiarid-arid	open deciduous woodlands, semideserts, seral vegetation
Afghanian	montane to subalpine	<i>P. flaccidum</i>	"	" " " " " "
E Anatol.-Tianshan.	subalpine to alpine	<i>P. laterale</i>	semiarid-semihumid	cushion-shrublands
N Iranian-Pamir	alpine	<i>P. platyanthum</i>	"	" " " " " "
Afghanian	subalpine to alpine	<i>P. barbellatum</i>	semiarid-arid	cushion shrublands, semideserts
"	alpine	<i>P. rechingeri</i>	arid	sand semideserts
Afgh.-Pamir.	"	<i>P. purpurascens</i>	semiarid	cushion shrublands
"	"	<i>P. pamiralaicum</i>	semiarid-semihumid	" " " " " "
"	subalpine to alpine	<i>P. angustifolium</i>	"	<i>Juniperus</i> --woodlands
Baluchistan. (fully transitional to NW Himalayan)	montane	<i>P. baluchistanicum</i>	semiarid	evergreen and deciduous woodlands, seral vegetation
<i>Sino-Himalayan</i>				
Himalayan	alpine	<i>P. gracile</i>	semiarid-arid	alpine meadows and steppes
NW-Himalayan	montane to subalpine	<i>P. hilariae</i>	semihumid-semiarid	evergreen oak and conifer-woodlands ( <i>Cedrus</i> )
Himalayan-Chinese	montane	<i>P. munroi</i>	semihumid	evergreen oak forests
Himalayan	"	<i>P. aequiglume</i>	humid	evergreen oak and conifer-forests

\* The terms used here for a closer circumscription of the areas within the Irano-Turanian and Sino-Himalayan regions should be considered in a mere geographical sense. For instance, "Turkmen.-Tianshan." means that the species is distributed from Turkmenia to the Tianshan. They have, however, been selected in such a way that they do show some aspects of phytogeographical subdivisions. Satisfactory classifications are not yet at hand but as the approach of Meusel, Jäger & Weinert (1965) seems reasonable, some of the terms have been taken from these authors.

11. *P. munroi* (Hook.f.) Mez  
[*P. ferganense* (Litv.) Roshev., Soviet Central Asia only, but to be expected in our area]  
Species-group 3 ('Breviaristata')
12. *P. molinioides* Boiss.
13. *P. flaccidum* Freitag  
[? *P. kokanicum* (Regel) Roshev., Soviet Central Asia only]
14. *P. baluchistanicum* Freitag
15. *P. barbellatum* Mez
16. *P. laterale* (Regel) Roshev.  
a. subsp. *laterale*  
b. subsp. *verticillatum* Freitag  
c. subsp. *alpestre* (Grig.) Freitag
17. *P. platyanthum* Nevski
18. *P. rechingeri* (Bor) Freitag
19. *P. gracilis* Mez
20. *P. hilariae* Pazij
- C. Subsect. Himalayana
21. *P. purpurascens* (Hack.) Roshev.
22. *P. pamiralaicum* (Grig.) Roshev.

Species not dealt with in this revision, and known only from outside our area, are cited in square brackets. Some of the other species names mentioned by Roshevitz (1951) have subsequently been transferred to *Stipa* [*P. keniense* (Pilg.) Roshev. = *Stipa dregeana* Steud., according to De Winter, 1965] or to *Achnatherum* [*P. parviflorum* Roshev. = *Achnatherum chinense* (Hitch.) Tzvel., according to Tzvelev, 1968].

In our area the following species has already been excluded: *P. longearistatum* Boiss. & Hausskn. in Boiss., Fl. Or. 5:509 (1884) = *Achnatherum longearistatum* (Boiss. & Hausskn.) Nevski in Trudy Bot. Inst. Akad. Nauk SSSR ser. I, 4:338 (1937).

#### TAXONOMIC ENUMERATION

**Piptatherum** P. Beauv., Ess. Agrost. 17 (1812).

Perennial, densely or loosely tufted, with intravaginal or extravaginal branching; culms 10–140 cm tall, 1–6 noded, usually glabrous; sheaths shorter than the internodes, glabrous or scabrous; ligules hyaline, 0.2–1.5 mm long; blade flat or involute to folded, 0.7–1.5 mm wide; panicle lax or contracted, at the lower nodes usually with 1–3(–5) branches; spikelets dorsally flattened, ovate to lanceolate, 1-flowered, with 2 subequal glumes, pale green, green, purple-tinged or yellow-rimmed; the rhachilla disarticulating above the glumes, mature fruits consisting of the caryopsis enclosed by palea and lemma with the attached callus; in outline ovate, obovate, elliptic or linear, dorsally flattened, 2–9 mm long; callus very short, 0.1(–0.3) mm long, usually incurved, rarely conical, rounded at the base, glabrous, with the outline of the articulation scar usually transversely elliptic, rarely circular and the scar itself never grooved; lemma becoming dark brown to black and shiny at maturity, coriaceous, glabrous or variously hairy,

only marginally covering the palea, with the awn inserted centrally; awn straight, erect, never twisted nor curved, 0.1–1.5 mm long, usually caducous, scabrous; palea alike, but slightly shorter, distinctly narrower and without awn; lodicules 3, glabrous, the lower ones broad or narrow ovate, acute, 2-nerved, the upper one usually narrower, almost linear with an obtuse apex without distinct nerves; ovary ovate to obovate in outline, glabrous; styles 2, inserted rather distantly at the apex, glabrous, bent outwards, each with one papillose stigma; caryopses ovoid, obovoid, ellipsoid or cylindrical, dorsally flattened, apically often with two short beaks as the remnants of styles, ratio of embryo:caryopsis=1:2–1:4, usually about 1:3, hilum usually reaching the top of the caryopsis or almost so, more rarely ratio hilum:caryopsis=3:4 or scarcely 1:2.

A medium-sized genus of 25 (or 26) species distributed in the Old World sub-tropics from Macaronesia to China, centred in the semi-arid and arid Irano-Turanian region and the adjacent parts of the Mediterranean and the Sino-Himalayan regions, including lowland species as well as montane and alpine species, mesophytic forest plants, and semi-desert xerophytes. Type species: *P. coerulescens* (Desf.) P. Beauv.

#### KEY TO THE SW ASIATIC AND E MEDITERRANEAN SPECIES OF *PIPTATHERUM*

- 1a. Lemma glabrous except for 2 basal tufts of hairs or eventually with an apical tuft of very short hairs (*P. angustifolium*) . . . 2
- b. Lemma variously hairy . . . 7
- 2a. Spikelets small, 3–5 mm long; lemma 1.5–2 mm long; panicle with branches in whorls of 3-to-many . . . 1. *P. miliaceum*
- b. Spikelets 5–7 mm long, pale; lemma never with an apical tuft of or solitary . . . 3
- 3a. Lemma ovate, widest below the middle, apex acute . . . 7a. *P. holciforme* var. *glabrum*
- b. Lemma elliptic or obovate, widest at or above the middle, apex obtuse . . . 4
- 4a. Lemma (2–) 2.5–3.5 mm long, broad elliptic to obovate; awn slender . . . 5
- b. Lemma 4–5 mm long, narrow elliptic; awn rather stout . . . 6
- 5a. Spikelets 4–5 mm long, purplish; lemma eventually with an apical tuft of short hairs; awn 1–2 mm long; anthers unbearded . . . 6. *P. angustifolium*
- b. Spikelets 5–7 mm long, pale; lemma never with an apical tuft of hairs; anthers bearded . . . 5. *P. vicarium*
- 6a. Upper surface of leaves densely pilose; awn 2–2.2 mm long, included; anthers bearded . . . 3. *P. coerulescens*
- b. Upper surface of leaves glabrous; awn 4–5 mm long, exserted; anthers unbearded . . . 4. *P. blanchetianum*
- 7a. Ligule very short, up to 0.5 mm; sheath ciliate at the margins; lemma obovate; awn persistent . . . 2. *P. virescens*
- b. Ligule at least 1 mm long; sheaths never ciliate; lemma of various shapes; awn caducous (if ± persistent, see *P. laterale*) . . . 8



- 8a. Awn more than 6 mm long; panicle usually lax . . . . . 9
- b. Awn less than 6 mm long; if about 5-6 mm long, then the panicle contracted . . . . . 14
- 9a. Lemma 3-4 (4.5) mm long . . . . . 10
- b. Lemma at least (4.5-) 5 mm long . . . . . 11
- 10a. Lemma lanceolate, at mature fruit up to 1.3 mm wide, hairy all over; length ratio of the longest branch to panicle less than 1:2 . . . . . 11. *P. munroi*
- b. Lemma ovate, at least 1.3 mm wide, hairy only in the upper half; length ratio of the longest branch to panicle more than 1:2 . . . . . 9. *P. songoricum*
- 11a. Lemma lanceolate, up to 1.3 mm wide . . . . . 12
- b. Lemma ovate to broad ovate, 1.4-2.2 mm wide . . . . . 13
- 12a. Panicle lax . . . . . 10. *P. aequiglume*
- b. Panicle contracted (sp. not yet recorded from our area, but possibly present—see p. 380) . . . . . *P. ferganense*
- 13a. Leaves 2-4(-6) mm wide; lemma 1.4-1.8 mm wide . . . . . 7. *P. holciforme*
- b. Leaves 6-13 mm wide; lemma broad ovate, 1.8-2.2 mm wide . . . . . 8. *P. latifolium*
- 14a. Mature lemma obovate or elliptic, at its widest at or above the middle (if in doubt follow b) . . . . . 15
- b. Mature lemma ovate, lanceolate or almost linear, at its widest clearly below the middle . . . . . 19
- 15a. Lemma covered with densely appressed hairs . . . . . 16
- b. Lemma with ascending hairs, at least near the apex . . . . . 17
- 16a. Lemma obovate, 2.5-3.5 mm long . . . . . 22. *P. pamiralaicum*
- b. Lemma elliptic or ovate-elliptic, 3.5-4.5 mm long . . . . . 21. *P. purpurascens*
- 17a. Spikelets 7-10 mm long; lemma 4.5-5.5 mm long, hairs near the rounded apex stiff, projecting; panicle contracted . . . . . 17. *P. platyanthum*
- b. Spikelets and lemma smaller; panicle lax or contracted . . . . . 18
- 18a. Lemma elliptic, somewhat beaked at the apex, the beak exceeded ventrally by bearded lemma lobes . . . . . 20. *P. hilariae*
- b. Lemma obovate, not beaked . . . . . 6b. *P. angustifolium* var. *pubescens*
- 19a. Lemma with 2 minute lobes at the apex; the awn subterminal, at the very base curved outwards . . . . . 20
- b. Lemma without apical lobes; awn terminal, not curved at base . . . . . 21
- 20a. Lemma ovate to elliptic, somewhat beak-like at the apex, loosely covered by 0.2-0.3 mm hairs, glabrous below the apex and the apex itself penicillate with a dense tuft of short hairs sprouting up from the lemma lobes; anthers glabrous or almost so . . . . . 20. *P. hilariae*
- b. Lemma narrow ovate to almost linear, densely covered by 0.4-0.5 mm stiff hairs up to the apex concealing the small apical lobes and exceeding the apical tuft of hairs; anthers bearded . . . . . 19. *P. gracile*
- 21a. Lemma hairy throughout . . . . . 22
- b. Lemma only partly hairy . . . . . 24

- 22a. Lemma hairs 1-2 mm long . . . . . 18. *P. rechingeri*  
 b. Lemma hairs 0.2-0.4 mm long . . . . . 23  
 23a. Lemma elliptic or ovate-elliptic, 1.5-2 mm wide . . . . . 17. *P. platyanthum*  
 b. Lemma clearly ovate, 0.8-1.3 mm wide . . . . . 16. *P. laterale*  
 a. Lemma  $\pm$  linear, near the apex very densely covered with short and thick botuliform hairs with rounded apices . . . . . 15. *P. barbellatum*  
 24b. Lemma ovate or lanceolate, hairs long and thin, with acute apices . . . . . 25  
 25a. Spikelets and lemma ovate, lemma 3.5  $\times$  1.3-4.5  $\times$  1.5 mm, loosely covered by almost appressed hairs, apical region glabrous, base often glabrescent . . . . . 14. *P. baluchistanicum*  
 b. Spikelets and lemma lanceolate, lemma only in upper  $\frac{1}{3}$  to  $\frac{1}{2}$  densely covered with ascending hairs usually exceeding the apex . . . . . 26  
 26a. Glumes almost completely hyaline, eventually with a purplish back; panicle flaccid or variously bent, with the main axis flexuose in the lower part . . . . . 13. *P. flaccidum*  
 b. Glumes never hyaline, purple-or yellow-rimmed; panicle erect, with stouter main axes and branches . . . . . 12. *P. molinoides*

In the descriptions that follow, synonyms are cited only as far as they have been mentioned in the literature of the area under review. Misapplied names are only considered in some cases; exsiccatae or herbarium names are omitted.

Illustrations of the anthesis, taxonomically of the greatest importance, are given for all the species reviewed (figs. 3 & 4). Distribution maps are also presented for all species. Literature records have only been accepted in a few cases. A selection of examined herbarium specimens is given in the main text; at the end of the paper is a list of other exsiccatae which were examined in the course of the study.

In the citation of the collectors, some names are abbreviated:

- |                   |                       |                      |
|-------------------|-----------------------|----------------------|
| A. —Anders        | Neub. —Neubauer       | V. —Volk             |
| B. —Breckle       | P. —Podlech           | W. —Hedge & Wendelbo |
| Bornm.—Bornmüller |                       | (Afghanistan) or     |
| F. —Freitag       | R. —Rechinger         | Wendelbo (Iran and   |
| K. —Koeie         | Stew. —Stewart, R. R. | Pakistan)            |
| Kerst.—Kerstan    |                       | Zoh. —Zohary         |

The locations of some of the private herbaria are indicated in the acknowledgments at the end of the paper.

#### I. SECT. MILIACEA [ROSHEV. EX] FREITAG

*Piptatherum* sect. *Miliacea* Roshev. in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 14:84 (1951)—non rite publicatum. Spiculis et antheis et caryopsidibus subcompressis, lemmate paleaque non coriaceis, lemmate ventraliter prope basin breviter connato, cicatrice circulari, callo recto, ratione hilum:caryopsis = 2:5-1:2. Sp. unica: *P. miliaceum* (L.) Coss.

Spikelets, anthesis and caryopses subcompressed; lemma and palea not coriaceous, lemma ventrally at the base shortly fused; articulation scar circular; callus straight; ratio hilum:caryopsis = 2:5-1:2. One species: a xerophyte of the arid to semiarid lowlands of Macaronesia and the S Mediterranean.

**1. *P. miliaceum* (L.) Coss. in Not. Crit. 129 (1851).**

In loose, large tufts, the thick rootstock with numerous generative and few or no vegetative shoots, branching extravaginal; culms slender to very stout, (40-)60-120(-150) cm, 5-7-noded, eventually branching at the lower nodes, smooth or slightly rough, remaining green after the leaves have dried off; sheaths glabrous; ligules truncate, 0.5-1.5 mm long; blades flat, up to 30 cm  $\times$  2-8(-10) mm, the upper surface scaberulous to scabrous, beneath glabrous; panicle lax, 15-30(-40) cm long, 6-12(-15) cm wide, the branches ascending to spreading, in whorls of 3-5-many, slender, scabrous; spikelets ovate to lanceolate, 3-3.5 mm long, with a greenish back and hyaline margins, rarely somewhat purplish, both glumes 3-nerved; lemma obovate to dumbbell-shaped, 1.5-2  $\times$  1 mm, with an obtuse apex, golden brown, with a prominent middle vein, glabrous, with 2 short apical lobes, ventrally at the base shortly fused, scar circular; awn 3-4 mm long, 2-3 mm exserted, subterminal, slender, caducous; lodicules 0.6-0.7 mm long, the lower ones ovate to obovate, the upper almost linear; anthers about 2-2.5 mm long, bearded; caryopsis obovoid, scarcely flattened, 1.5-1.7  $\times$  0.6-0.8 mm, ratio embr.:car. = 1:3, ratio hilum:car. 2:5-1:2.  $2n = 24$  (Avdulov 1928, Tateoka 1957). (Fig. 3a).

From Macaronesia through the whole Mediterranean region, in wadis and oases deeply penetrating into the semi-deserts of N Africa, Sinai and the Near East, with a few outliers in Iraq (fig. 17). Naturalized in S Africa and in SW North America.

A very common species of various disturbed habitats with a tendency to nitrophily; at roadsides, along ditches, at field borders, on dumping grounds, in dry river beds; only in Sinai and Jordan up to 2000 m.

- 1a. Panicle loosely verticillate, the lower whorls with 3-5 spikelet-bearing branches . . . . . a, subsp. *miliaceum*
- b. Panicle densely verticillate, the lower whorls with 15-30 or more often sterile branches . . . . . b, subsp. *thomasi*

**a. subsp. *miliaceum***

Syn.: *Agrostis miliacea* L., Spec. Plant. 61 (1753).

*Oryzopsis miliacea* (L.) Aschers. & Schweinf. in Mém. Inst. Egypt 2:169 (1887).

*O. pauciflora* Beg. & Vacc. in Ann. Bot. (Roma) 12:94 (1914). Type: Libya, Tripoli, nell'oasi a Sciara Sciati [Charachat], 2 vi 1913, *Vaccari* (holo. RO—non vidi).

For a full citation of the voluminous synonymy see Roshevitz (1951, p.92). Type. S Europe (LINN—according to Roshevitz, 1951—non vidi).

TURKEY. Hatay: Arsouz, v 1933, *Delbes*.

LEBANON. Saida, 29 v 1873, *Gaillardot*. Tripoli, 22 viii 1864, *Blanche*. Brummana, 700-800 m, *Bornm.* 1620.

SYRIA. Damascus, 29 x 1876, *Gaillardot*.

ISRAEL. Upper Jordan: Deganiya, 16 iv 1941, *Zoh.* Upper Galilee: Meiron, 25 iv 1942, *Feinbrun*. Carmel: 23 iv 1913, *Eig.* Sharon Plain: Kabbara, 27 v 1926, *Eig.* & *Zoh.* Judaean Mts.: Soreq bridge near Hartuv, 3 ix 1962, *Zoh.* Jerusalem, 9 iv 1940, *Zoh.* Negev: Sede Bogger, 12 vi 1958, 21 vi 1958, *Waisel*.

JORDAN. Moab: Amon, 3 iv 1925, *Eig.* Judean Desert: Wadi Qilt, 15 v 1932, *Eig & Feinbrun.* Edom: Petra, 17 iv 1929, *Eig & Zoh.*  
 SINAI. Wadi Sheikh, 1000 m, 8 v 1940, *Zoh. & Feinbrun.*

**b. subsp. thomasi** (Duby) Boiss., *Fl. Or.* 5:507 (1884).

Syn.: *Milium thomasi* Duby, *Bot. Gall.* 1:505 (1828).

*Piptatherum thomasi* (Duby) Kunth, *Enum. Gram.* 1:177 (1833).

Type. Corsica, ad promontorium Capa Corso, *Thomas* (holo. G—non vidi).

TURKEY. Hatay: Kavaiana near Alexandrette, 10 viii 1931, *Eig & Zoh.*

Mt. Silpius near Antakya, 150–200 m, *Delbes* s.n.

LEBANON. Saïda, 12 xi 1874, *Gaillardot.*

SYRIA. Hatsbani, 10 viii 1929, *Gabrielith.* Hermon, 450 m, 9 vii 1924, *Eig.*

ISRAEL. Sharon plains: Wadi Rubin, 25 iv 1945, 3 ix 1962, *Zoh.* Philistaeen

plain: Rehovoth, 15 v 1931, *Naftolsky.* Esdraelon plains, Merhavva, vii 1921,

*Naftolsky.* Mikne Israel, 26 v 1922, *Eig.*

IRAQ. Shaikh Adi Gorge, 14 vii 1933, *Guest.*

In contrast to the other subspecies, ssp. *thomasi* significantly does not penetrate into the semi-deserts.

In wadi beds of the semi-desert and desert areas of Palestine and Syria often grow more delicate forms, which have been described as *O. pauciflora*, and which are dealt with by Roshevitz (1951) as var. *pauciflora*. From the investigation of the rich material at Jerusalem (HUJ), I formed the opinion that few flowered and smaller specimens are either young ones fruiting for the first time, or more commonly that they were growing under very dry conditions. Because all intermediates occur, even varietal rank seems too high.

## II. SECT. VIRESCENTIA [ROSHEV. EX] FREITAG

*Piptatherum* sect. *Virescentia* Roshev. in *Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR* 14:86 (1951)—non rite publicatum. Spiculis et antheis et caryopsidibus subcompressis, lemmate paleaque coriaceis, lemmate ventraliter prope basin breviter connato, cicatrice circulari, callo recto, ratione hilum:caryopsis = 4:5. Sp. typica *P. virescens* (Trin.) Boiss.

Spikelets, antheia and caryopses subcompressed; lemma and palea coriaceous; lemma ventrally at the base shortly fused; articulation scar circular; callus straight; ratio hilum:caryopsis = 4:5. Two closely allied allopatric species from mesophytic forests of the humid Mediterranean and submediterranean, from lowlands to the montane belt.

**2. P. virescens** (Trin.) Boiss., *Fl. Or.* 5:507 (1884).

Syn.: *Urachne virescens* Trin., *Gram. uniflor.* 173 (1824). The nomen "*U. virescens* Trin.", *Fund. Agrost.* 110 (1820) refers.

*Oryzopsis virescens* (Trin.) Beck, *Fl. Nieder-Oesterr.* 1:51 (1890).

Type. Several syntypes from S Europe, according to Roshevitz, 1951, (LE—non vidi).

In large tufts, with numerous generative and vegetative shoots, branching extravaginal; culms 50–70(–100) cm, 3–4-noded, slender, glabrous, sheaths glabrous or scaberulous in their upper parts, distinctly ciliate at the margins, bearded at the junction with the blades, the lowermost ones often purplish; ligules very short, 0.2–0.3 mm long, incised, brownish; blades flat, strictly

erect or ascending, at the culm leaves up to 15 cm  $\times$  7(-9) mm, at the vegetative shoots up to 25 cm  $\times$  7 mm, glabrous on both surfaces, only at the apex scaberulous; panicle lax, 8-20(-26) cm long, 3-15 cm wide, the branches ascending, very slender, paired or in whorls up to 4, scabrous; spikelets lanceolate, 3.5-4.5 mm long, glumes with green back and hyaline margins, lower glume 5-, upper 3-nerved; mature lemma obovate, 3.3-3.8  $\times$  1.0-1.5 mm, with an obtuse apex and 2 distinct apical lobes, loosely covered all over with slightly ascending 0.2-0.4 mm long white hairs, the middle vein on the back marked by a longitudinal groove, ventrally near the base fused, with 2 tuberculate areas, scar circular; awn 10-13 mm long, 9-11 mm exerted, subterminal, slender, irregularly bent, persistent; lodicules 0.7-0.9 mm long, the lower ones ovate, the upper almost linear with variable shape at its apex; anthers 2.5-3.2 mm long, yellow, bearded but sometimes with scattered and very short hairs only; caryopsis obovoid, 2.2-2.5  $\times$  1.3-1.4 mm, ratio embr.:car. = 1:3, ratio hilum:car. = 4:5.  $2n = 24$  (Avdulov 1928, Johnston 1945). (Fig. 3b).

From S France through the Balkan peninsula to N Anatolia, the whole of the Caucasus (USSR) and the Elburz in N Iran; scattered also in S Anatolia (fig. 18).

A rather common and highly characteristic species of mesophytic broad-leaved deciduous forests and shrub-vegetation, also in *Abies* forests; in our area from the lowlands up to about 2000 m, but mainly from 500-1500 m.

TURKEY. Hatay: Amanus, Celdrin pass between Celdrin and Bujuk Aba, 27 viii 1931, *Eig & Zoh.*

USSR. Daghestan, 1844, *Koch.* Grusia: d. Gori, in Tana valley, 24 v 1910, *Woronow.*

IRAN. Mazanderan: Haraz at Mamgol, 750 m., W. 493.

Because of its pronounced mesophytic character, this species does not enter the Irano-Turanian region. Identification poses no problems. The only species closely related to *P. virescens* is *P. paradoxum* (L.) P. Beauv. from the W Mediterranean with much larger lemmas.

### III. SECT. PIPTATHERUM

*Piptatherum* sect. *Holciformia* Roshev. in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 14:86 (1951).

Spikelets, anthecia and caryopses distinctly compressed; lemma and palea coriaceous; lemma ventrally at the base not fused; articulation scar transverse elliptic; callus incurved; ratio hilum:caryopsis = 4:5-9:10. Twenty-two species (or 23); in most diverse habitats from humid subtropical lowlands to montane semi-deserts and alpine environments; in the whole area of the genus from Macaronesia to China. Type species: *P. coerulescens* (Desf.) P. Beauv.

#### III A. SUBSECT. COERULESCENTIA [ROSHEV. EX] FREITAG.

*Piptatherum* sect. *Piptatherum* subsect. *Coerulescentia* Roshev. in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 14:100 (1951)—non rite publicatum. Lemmate ambitu elliptico, apice obtuso, plerumque glabro raro pilis ascendentibus tecto. Sp. typica: *P. coerulescens* (Desf.) P. Beauv.



Lemma elliptic in outline, with obtuse apex, usually glabrous, rarely with ascending hairs. Five species; moderate xerophytes of lowland and montane woodlands; in the whole area of the genus. All the species are closely allied, but *P. coerulescens* and *P. blancheanum* on the one hand and *P. vicarium* and *P. angustifolium* on the other have stronger affinities to each other.

**3. *P. coerulescens* (Desf.) P. Beauv., Ess. Agrost. 18 (1812).**

Syn.: *Milium coerulescens* Desf., Fl. Atlant. 1:66 (1798).

*Agrostis coerulescens* (Desf.) Poir., Encycl. Suppl. 1:258 (1810).

*Urachne coerulescens* (Desf.) Trin., Fund. Agrost. 110 (1820).

*Oryzopsis coerulescens* (Desf.) Hack. in Denkschr. Akad. Wiss. Wien, Math.-nat. Kl. 50, 2:85 (1885).

Type. NW Africa: in fissuris rupium Atlantis, *Desfontaines* (holo. P—non vidi).

In large tufts, with numerous generative and generally less vegetative shoots, branching extravaginal; culms (30–)50–80(–100) cm, (3–)4-noded, somewhat papillose but smooth or (the lower internodes) tuberculate and scabrous; sheaths more or less scabrous; ligules at the culm leaves (3–)4–7(–9) mm long, at the vegetative shoots 2–4 mm, obtuse to acute; blades flat or involute, usually 10–20(–30) cm  $\times$  1.5–2.5(–4) mm, upper surface densely pilose, beneath rather smooth near the base, grading into scaberulous; panicle lax, (6–)8–15(–21) cm long, (1–)4–10(–15) cm wide, the branches ascending to spreading or somewhat reflexed, paired or solitary, scabrous, the longest about half of the panicle; spikelets lanceolate, (6–)7–8(–9) mm long, glumes with purple-tinged back and broad or narrow yellowish or hyaline margins and tip, the lower 7-nerved and 1–1.5 mm longer than the upper, 5-nerved one; mature lemma elliptic, 4–4.5(–5)  $\times$  1.2–1.3 mm, with an obtuse apex, glabrous except 2 tufts of hairs near the base; awn 2–2.2 mm long, included, rather strong, terminal, straight, caducous; lodicules about 1 mm long, the lower ones ovate, the upper narrow elliptic; anthers 2.0–2.5 mm long, yellow, bearded; caryopsis ellipsoid, dorsally slightly compressed, 2.5–3  $\times$  1.2–1.3 mm, ratio embr.:car. = 1:3, hilum almost reaching the apex. (Fig. 3c).

Almost circum-Mediterranean, but evidently absent from Palestine and doubtfully in the Lebanon and most parts of coastal Syria (fig. 15).

A common and characteristic species of the true Mediterranean area, growing in evergreen woodlands and in different seral dwarf-shrublands, up to c. 800 m.

TURKEY. Bursa: Mudanya, *Bornm.* 5638. Izmir: Sinus Smyrnaeus, 200 m, *Bornm.* 10132. Hatay: Arabali, 100–200 m, iv 1932, *Delbes.* Antalya: Antalya, 28 iv 1860, *Bourgeau.*

CYPRUS. Troodos mts., Platres, 1300 m, 23 vii 1937, *Grizzi.*

This well-known Mediterranean species enters our area only in its westernmost part.

**4. *P. blancheanum* [Desv. ex] Boiss., Diagn. sér. 2, 4:127 (1859).**

Syn.: *P. holciforme* (M. Bieb.) Hack. var. *blancheanum* (Boiss.) Boiss., Fl. Or. 5:508 (1884).

*Oryzopsis holciformis* var. *blancheana* (Boiss.) Bornm. in Beih. Bot. Centralbl. 31, 2:267 (1914).

Type. [Lebanon] circa Saida, *Blanche* s.n. (holo. G—non vidi).

In large, loose tufts, with numerous generative and usually only a few vegetative shoots, branching extravaginal; culms (50-)60-90(-100) cm, (3-)4-noded, glabrous; sheaths smooth to scaberrulous; ligules (3-)5-10(-15) mm long, obtuse or acute; blades of the culm leaves flat, (5-)10-20(-30) cm  $\times$  (1.5-)2-4(-6) mm, upper surface glabrous, beneath smooth but papillose, near the apex grading into scabrous; panicle lax, (6-)10-20(-25) cm long, (2-)4-10(-16) cm wide, the branches ascending to spreading, paired or solitary, scabrous, the longest about half of panicle length; spikelets lanceolate, 7-9(-9.5) mm long, glumes with purple-tinged back and narrow yellowish margins, sometimes completely purplish, the lower 7-9-nerved, the upper 5-7-nerved; mature lemma narrow elliptic, (4-)4.5-5  $\times$  1.3-1.6(-2) mm, with an obtuse apex, glabrous except 2 tufts of hairs near the base; awn (4-)4.5-5(-6) mm, 1-2 mm exerted, rather strong, terminal, straight, caducous; lodicules 1 mm long, the lower ones broad ovate, the upper narrow elliptic; anthers 2.8-3.6 mm long, yellow, unbearded; caryopsis ellipsoid, dorsally slightly compressed, 3-3.5  $\times$  1.2-1.4 mm, ratio embr.:car. = 1:3, hilum almost reaching the apex. (Fig. 3d).

Mediterranean S Turkey through coastal Syria and Lebanon to Palestine (fig. 14).

Rather common in evergreen woodlands and in different seral dwarf-shrublands ("batha"), up to 700(-900) m.

TURKEY. Hatay: Antiochia, 8 v 1931, Zoh.

SYRIA. El Ourdo, 20 km S, 4 vii 1932, Eig & Zoh.

LEBANON. Tripoli, 18 viii 1866, *Blanche*; 27 iv 1868, *Blanche*. Saida, between Halalé and Baramie, 21 v 1853, Gaillardot.

PALESTINE. Lower Galilee: Beit Qeshet, 30 iii 1954, *Sheinkar*. Mt. Carmel, 100-300 m, Bornm. 1621; 12 iv 1895, Post. Sharon: Tantura, 19 iii 1956, Ginzburg. Philistaeen plain, Gedera, 31 iii 1928, *Naftolsky*. Mt. Ebal, *Davis* 4337 p.p., Judaeen Mts., Deir-el-Hawa, 25 iv 1954, *Jaffe*. Jerusalem, 20 iv 1931, *Amdursky* p.p.; *Meyers & Dinsmore* 687b.

In the original description, Boissier (1859) compared *P. blancheanum* with *P. coeruleascens*, which indeed is the closest relative both morphologically and ecologically. The differential characters are somewhat weak (see key to species), but as together they sum up a whole complex, separation at specific level seems justified. Only in the case of the anther character did I meet with intermediates. Geographically, *P. blancheanum* replaces *P. coeruleascens* in the E Mediterranean south of the Amanus.

Boissier (1884) later reduced his species to a variety of *P. holciforme*, and was followed by Bornmüller (1914) and such authors of Near East Floras as Post (1896, 1933) and Mouterde (1966). Nevertheless by the elliptic, boat-like shape of the lemma *P. blancheanum* differs fundamentally from the rare glabrous forms of *P. holciforme*, which always have lanceolate to ovate lemmas with acute apices. Unfortunately some uncertainty remains, because the type has not been seen. I was, however, able to investigate three other *Blanche* and *Gaillardot* specimens from near the type locality.

5. *P. vicarium* (Grig.) Roshev. in Schischkin, Fl. Kirgiz. SSR 2:64 (1950).

Syn.: *Oryzopsis vicaria* Grig. in Trudy Tadzh. Baz. Akad. Nauk SSSR 8:574 (1938).

*O. microcarpa* Pilg. in Notizbl. Bot. Gart. Mus. Berlin 14:346 (1939).

Types: Kashmir, Nanga Parbat, Astor Tal, Daschkin, in Artemisiengesträuch zwischen Büschen und Steinen, 2400 m, 30 v 1937, Troll 7272 (B—destroyed); Swat, Stewart s.n. (neo.—Bor., 1960—K!). The nomen "*O. pallida* Stapf ex Duthie" (Rec. Bot. Surv. Ind. 1:177, 1898) probably belongs here.

Type. USSR, C Asia: Shugnan [valley of Pjandzh river beneath Korogh and Nishus], 30 v 1914, Tuturin & Besedin 81 (holo. LE!).

In large, dense tufts, with numerous generative and vegetative shoots, branching predominantly extravaginal; culms (30–)50–60(–100) cm, 4–5-noded, glabrous; sheaths glabrous; ligules at the culm leaves (3–)5–8(–10) mm long, ± acute, at the vegetative shoots (2–)3–4(–5) mm long, obtuse; blades flat or involute, at the culm leaves up to 20 cm × (1.2)2–3(–4) mm, at the vegetative shoots up to 25(–30) cm × (1.0–)1.2–2(–3) mm, upper surface minutely pilose, beneath glabrous grading into scabrous towards the apex; panicle lax, (7–)15–25(–35) cm long, (3–)5–20(–25) cm wide, the branches ascending or spreading, paired or solitary, very slender, scabrous, the longest about half of panicle; spikelets lanceolate, (5.0–)5.5–7(–8) mm long, pale green, the glumes with a small green blotch at the base, otherwise hyaline or somewhat yellow-tinged, lower glume 7-, upper 5-nerved; mature lemma elliptic, (2.6–)2.8–3.3(–3.5) mm long, with an obtuse apex, glabrous except 2 basal tufts of hairs; awn (2–)3–4(–5.5) mm long, included to 1 mm exserted, almost terminal, straight, slender, caducous; lodicules 0.9–1 mm long, the lower ones ovate to obovate, the upper narrower; anthers 1.5–1.7 mm long, yellow, bearded; caryopsis ellipsoid, dorsally compressed, 2.2–2.5 × 1.1–1.3 mm, ratio embr.:car. = 2:5, hilum almost reaching the top. 2n = 24 (Podlech & Dieterle, 1969). (Fig. 3c).

From Khorasan in NE Iran and S Turkmenia through N Afghanistan, the Pamir-Alai and W Pamir up to the Tianshan in the USSR; S of the Hindukush in SE and E Afghanistan and in the adjacent parts of Pakistan up to Chitral and Gilgit (fig. 15).

A common species of open, usually deciduous woodlands (*Pistacia vera*, *P. atlantica*, *Amygdalus kuramica*) and of different types of open vegetation, preferring talus, between 500 and 1500 m in the N and 1200–2300 m S of the Hindukush.

AFGHANISTAN. Faryab: Darra Abdullah, 1200 m, *W.* 3712. Balkh: Ali Kuh, 18 km S of Mazar-e-Sharif, 1600 m, *W.* 8496. Samangan: SE of Tashkurgan at road to Samangan, 600 m, *W.* 3983, *R.* 16350, *F.* 5104. Baghlan: Koh-e-Chungar, WNW Pul-e-Khumrie, 900–1110 m, *F.* 3079. Takhar: upper Farqar valley, 1600–2500 m, *Furse* 8171. Bamyan: Ajar valley, 1400–1500 m, *R.* 16617. Parwan: upper Ghorband valley, 2200 m, *V.* 469; *A.* 6502. Kabul: upper Tang-e-Gharu, 1800 m, *W.* 3068; *ibid.*, 1740 m, *A.* 3649, *F.* 2812. Maydan: upper Maydan valley near Takona, 2700 m, *F.* 2963. Kandahar: Dahla, at road to Tirin, 1450 m, *F.* 849. Paktya: between Chamkanni and Ahmad Khel, 1850 m, *R.* 35663. Laghman: Alishang valley, Dawlatshah, 1600 m, *A.* 3315.

PAKISTAN. Baluchistan: Quetta (prob.), *Lace* s.n. Kohat: Cherat, SE Peshawar, 700-950 m, R. 30244. Chitral: Ziarat (Lowarai pass), 2200 m, *Stainton* 2549.

USSR. Tianshan: Mogol-tau at Tschaschma Arzanak, *Vvedensky* 674.

The species has much in common with the Mediterranean *P. coerulescens*, especially in the loose panicle and the glabrous and elliptic lemmas, but they differ in the smaller size of lemma and the pale glumes of *P. vicarium*. Furthermore, the areas of both species are geographically separated, with *P. coerulescens* in the Mediterranean and *P. vicarium* in the Irano-Turanian region.

**6. *P. angustifolium* (Regel) Boiss., Fl. Or. 5:508 (1884).**

In small, dense tufts, with some generative and numerous vegetative shoots, branching intravaginal; culms (20-)30-60(-75) cm, slender, often geniculate at base, (3-)4(-5)-noded, glabrous or minutely papillose; sheaths striate, glabrous to papillose; ligules of the culm leaves 3-6(-8) mm long, acute, at the vegetative shoots (1.5-)2-4 mm long, obtuse to truncate, sometimes lacerated; blades mostly involute, greyish, culm leaves up to 12(-17) cm  $\times$  (1.2-)1.5-2.5(-3.1) mm, leaves of vegetative shoots up to 15(-21) cm  $\times$  (0.75-)1-2 mm, on the upper surface minutely pilose, beneath scaberulous at the apex only, rarely scaberulous to scabrous throughout, panicle usually lax, (6-)10-17(-20) cm long, (1-)3-10(-15) cm wide, the branches spreading or partly reflexed, the lower ones paired, rarely in 3, very slender, scabrous, the longest about half of panicle; spikelets lanceolate, (3.5-)4-5(-5.5) mm long, usually variegated, glumes with a basal green spot surrounded by a purple zone, yellow-rimmed and purple-tipped, rarely the purple component fading, both glumes 5-nerved or the upper only 3-nerved; lemma elliptic, widest diameter between slightly below and above the middle, (2-)2.5-3  $\times$  1.2-1.5 mm, with an obtuse apex, glabrous except 2 basal tufts of hairs, often also with an apical tuft of short brownish hairs at the sides of the lemma, more rarely covered throughout with white ascending hairs, scar transversely elliptic; awn 1-2.5 mm long, included or up to 0.5 mm exerted, terminal, slender, caducous; anthers 1.5-1.7 mm long, purple, unbearded; lodicules 0.7-0.9 mm long, the lower ones ovate to obovate, the upper more linear; caryopsis ellipsoid, dorsally slightly compressed, 1.5-2.1  $\times$  0.9-1.2 mm, ratio embr.:car.=1:3, ratio hil.:car.=6:7. (Fig. 3f).

From Paktya and eastern C Afghanistan through Nuristan to the W Pamir (fig. 7).

A rather common species of medium and higher altitudes in-between (1300-)1700 and 3000 (-3300) m, in woodlands of *Pinus gerardiana*, *Cedrus deodara*, *Juniperus seravschanica*, *Amygdalus kuramica* and in secondary dwarf-shrub vegetation.

- |     |  |                              |
|-----|--|------------------------------|
| 1a. | Lemma completely glabrous or with one apical and two basal tufts of hair | a, var. <i>angustifolium</i> |
| b.  | Lemma hairy throughout   | b, var. <i>pubescens</i>     |

**a. var. angustifolium**

Syn.: *Milium coerulescens* Desf. var. *angustifolium* [Munro ex] Regel in Trudy Bot. Sada Akad. Nauk SSSR 7:644 (1880). The nomen "*Piptatherum angustifolium* Munro" in Journ. Linn. Soc., Bot. 18:106 (1880) refers.

*Oryzopsis angustifolium* (Regel) Kitamura, Results Kyoto Univ. Sci. Exped. 2:40 (1960).

Type. Afghanistan: Kurram valley, Biankhel, Alikhel, common in pine woods, v 1879, *Aitchison* 527 (lecto. E; isolecto. K!, LE).

AFGHANISTAN. Bamyan: at Bulola, 2780 m, *Gilli* 422a. Parwan: S Salang, 1350 m, *F.* 2655; 1900 m, *P.* 21047. Maydan: Unai pass, near village, 3000 m, *W.* 4539. Kabul: Paghman mts., 1900 m, *K.* 2298b; Korogh Koh, 2300 m, *F.* 1589. Logar: Shutur Gardan pass, 3250 m, *F.* 5756. Paktya: Peiwar pass, 2650-2800 m, *R.* 32248. Laghman: Alishang, Darrah Rastyon, 2700 m, *W.* 9687. Kunar: pass between Waigelek and Badschaigal, 2700 m, *Kerst.* 1198b.

**b. var. pubescens** (Bor) Freitag, **comb. nov.**

Syn.: *Oryzopsis microcarpa* Pilger var. *pubescens* Bor in Rechinger, Flora Iranica 70:405 (1970).

Type. Afghanistan: Parwan, in declivibus austral. jugi Salang, 2300-2600 m, *Rechinger fil.* 31363 (holo. W!).

Afghanistan. Parwan: S Salang pass, 1800 m, *A.* 3787; *ibid.*, 2150 m, *P.* 18090. Kabul: upper Tang-e-Gharu, 1700 m, *A.* 3652!

Var. *pubescens* was ascribed by Bor (1970) to *O. microcarpa* (= *P. vicarium*), but according to the differential characters (see tab. 8) it is better placed in *P. angustifolium*.

*P. angustifolium* and *P. vicarium* are closely related. In typical forms they differ in so many features that I follow the view of Roshevitz (1951) in treating them as separate species (see tab. 8). Forms intermediate between them may be caused by hybridisation. They have been collected at altitudes where both species are present. Generally the area of *P. angustifolium* is within the much wider one of *P. vicarium*, but restricted to higher altitudes.

TABLE 8  
Differential characters of *P. angustifolium* and *P. vicarium*

	<i>P. angustifolium</i>	<i>P. vicarium</i>
Spikelet: length in mm ; colour	(3.5-)4-5(-5.5) variegated (green, yellow and purple)	(4.5-)5-7(-8) pale (green, with broad hyaline margins)
Lemma, surface	often with apical tuft of hairs	always glabrous
Awn, length in mm	1-2.5	2-3(-5)
Anthers	unbearded	bearded
Leaves, underside	usually smooth	usually rough
Altitudinal range	1700-3300 m	400-2000 m

Recently Tzvelev (1960) reported *P. angustifolium* from higher parts of the Shugnan area in the W Pamirs. Pazij (1968), however, disagreed with



this identification, insisting on the presence of apical hairs on the lemma, as is shown by the type of *P. angustifolium*. But in the light of the rich Afghan collections now at hand, with some specimens having no apical hairs, Tzvelev's identifications may be correct.

### III B. SUBSECT. HOLCIFORMIA [ROSHEV. EX] FREITAG

*Piptatherum* sect. *Piptatherum* subsect. *Euholciformia* Roshev. in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 14:105 (1951)—non rite publicatum. Lemmate ambitu lanceolato vel ovato, raro fere elliptico, apice acuto, plerumque pilis ascendentibus tecto. Sp. typica: *P. holciforme* (M. Bieb.) Roem. & Schult.

Lemma lanceolate or ovate in outline, rarely almost elliptic, with acute apex, usually covered with ascending hairs. Fifteen species (or 16); of most diverse habitats; from the E Mediterranean to China. The subsection includes the series *Holciformia*, *Molinioidea* and a part of *Himalayana* of Roshevitz (1951), all of them published in Russian only.

#### Species-group 1 ('Ovata')

Lemma ovate in outline, awn 7–15 mm long. Three species; moderate xerophytes of the lowlands and the submontane belt from the E Mediterranean to the Altai. Almost allopatric, the three species are closely allied and can be considered as forming a series.

#### 7. *P. holciforme* (M. Bieb.) Roem. & Schult., Syst. Veg. 2:238 (1817).

In rather large tufts, usually with numerous generative and fewer vegetative shoots, branching intravaginal to extravaginal; culms (30–)60–100(–130) cm, 3–4(–5)-noded, glabrous; sheaths glabrous; ligules at the culm leaves 3–7(–10) mm long, obtuse to acute, often lacerated, at the vegetative shoots shorter and more obtuse; blades flat or involute, at the culm leaves up to 25(–30) cm × 2–5(–6) mm, at the vegetative shoots somewhat longer and narrower, upper surface glabrous, more rarely minutely pilose to scaberulous, beneath glabrous in the basal part and scaberulous to scabrous towards the apex, or scaberulous to scabrous throughout; panicle lax, (11–)15–30(–37) cm long, (2–)4–15 cm wide, the branches erect or ascending to spreading, the lower ones paired, rarely in whorls up to 4, scabrous, at least in upper part, the longest about half of panicle or more; spikelets ovate to lanceolate, (7–)8–13(–14) mm long, glumes with a green back and hyaline to yellowish margins and tip, lower glume 5–8-nerved, upper 5–7-nerved; lemma at maturity ovate to broad lanceolate, (4.5–)5–8(–9) × 1.4–1.8 mm, with an acute apex, covered with slightly ascending white to brownish 0.2–0.3 mm long hairs, at the apex usually glabrous, along the dorsal line often glabrescent, at least in the basal part, rarely completely glabrous, scar transversely elliptic to linear; awn (5–)6–14(–18) mm long, (3–)5–11(–14) mm exserted, terminal, slightly bent, caducous, lodicules 1 mm long, the lower ones broad ovate, the upper almost linear; anthers 3–4.5 mm long, yellow, bearded, but sometimes with short scattered hairs only; caryopsis ellipsoid, dorsally slightly compressed, 3–3.5 × 1.5 mm, ratio embr.:car. = 1:3, hilum almost reaching the top. 2n=24 (Johnson 1945). (Fig. 3g).

From the Balkan peninsula and Crimea through Turkey in one line to Palestine with outposts on the Sinai mts., in another line along the Zagros

mts., to S Iran, in a third line through the Caucasus and Elburz to the Kopet Dag in NE Iran and Turkmenia; outposts in N Afghanistan, Kazakhstan (Karatau) and Libya (fig. 16).

Rather frequent in very different types of woodland and seral shrub- and dwarf shrub-communities, centred in the deciduous oak- and in pine-areas; in the N and W from 0–1800 m, in the S and E only in montane regions; the highest altitudinal records are 2700 m in SW Iran and Sinai.

- |     |   |  |
|-----|---|--|
| 1a. | Spikelets 7–10 mm long; lemma 5–6 mm long; awn 5–8 mm long      | 2  |
| b.  | Spikelets 10–14 mm long; lemma 6.5–9 mm long, awn 11–14 mm long | 3  |
| 2a. | Lemma hairy   | a, subsp. <i>holciforme</i> var. <i>holciforme</i> |
| b.  | Lemma completely glabrous                                       | a, subsp. <i>holciforme</i> var. <i>glabrum</i>    |
| 3a. | Lemma hairy   | b, subsp. <i>longiglume</i> var. <i>longiglume</i> |
| b.  | Lemma completely glabrous                                       | b, subsp. <i>longiglume</i> var. <i>epilosum</i>   |

**a. subsp. *holciforme* var. *holciforme***

Syn.: *Agrostis holciformis* M. Bieb., Fl. Taur. Cauc. 1:54 (1808).

*Urachne grandiflora* Trin., Gram. uniflor. 174 (1824).

*Milium holciforme* (M. Bieb.) Spreng., Syst. Veg. 1:251 (1825).

*Urachne holciformis* (M. Bieb.) C. Koch in Linnaea 21:439 (1848).

*U. sinica* Steud., Syn. Pl. Glum. 122 (1855). Type: [Sinai] In monte St. Catharinae, *Schimper* 312 (iso. W!).

*Oryzopsis holciformis* (M. Bieb.) Hack. in Denkschr. Akad. Wiss. Wien, Math.-nat. Kl. 50:8 (1885).

*O. kopetdaghensis* Roshev. in Komarov, Fl. URSS 2:743 (1934).

Type: USSR, Turcomania, in rupestribus m. Kopet Dag, inter st. Kurtsu et Gaudan, 29 iv 1912, *Lipsky* 2418 (LE—non vidi).

*Piptatherum karataviense* Roshev. in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 14:110 (1951). Type: USSR, Asia media, in montibus Karatau, pylae Bajadyr, in locis saxosis inter Dshangil-schik et Ken-sai, 17 v 1930, *Lipschitz* 240 (LE—non vidi).

Type. USSR, Crimea: in Tauria meridionale, circa pagum Alupkam, *M. Bieberstein* (LE—non vidi).

USSR. Crimea: Sokoll at Sudak, *Callier* 245. Armenia: Mikojanski rayon, around Shabik in Elegis valley, *Gabrislok*. Turkmenia: distr. Ashkhabad, between Hairabad and Tschaek, *Michelson*.

TURKEY. Izmir: between Izmir and Manisa, 700 m, *Balansa* 3. Antalya: Antalya, near sea, *Bourgedu* 276. Kastamonu: Tosya, *Sinten* 4943. Çankiri: at Çankiri, 800 m, *Bornm.* 14675. Ankara: 10 km N of Ankara, 13 vii 1962, *Zoh.* Amasya: near Amasya, 400–600 m, *Bornm.* 431. Sivas: 28 km E of Resadiye, 660 m, 9 vii 1963, *Zoh.* Erzincan: between Kemaliye and Rota, *Sinten* 2564. Erzurum: gorge NE Tortum, 1100 m, *Markgraf* 11006. Mersin: Karli Boghaz, 1859, *Kotschy*. Adana: Pozanti, 900 m, *Markgraf* 11251. Maraş: Beryt Dag, 2600 m, 9 viii 1865, *Hausskn.* Hatay: Amanus above Belen, 1866, *Hausskn.*

IRAQ. Amadiya: Gara Dag, 1050 m, 11 ix 1933, *Eig & Feinbrun*. Suleimaniya: Pir-i-Mukrun Dag, *Eig & Duvdevani*.

IRAN. Luristan: Tang Malli, 2300 m, *Hausskn.* Esfahan: between Esfahan and Schahrud, 9 v 1859, *Bunge*. Chonsar [Khunsar], Kuh-i-Domine, vii 1908,

*Strauss*. Fars.: Kuh Bannu near Shiraz, 9 vii 1885, *Stapf*. Kerman: Jebal Barez between Bam and Jiroft, 1900 m, *R.* 3829. Khorasan: 150 km NE Meshed, 30 v 1961, *Zoh.* & *Orshan*.

AFGHANISTAN. Takhar: 12 km SE of Eshkamesh, 1300–2100 m, *A.* 6814.

var. **glabrum** Freitag var. **nov.** Differt lemmate omnino glabro. Differs in the completely glabrous lemma.

Type. Turkey: Konya, Sultandagh in saxosis et rupestribus prope Aksehir, 1100 m, 14 vi 1899, *Bornmüller* 5639 (holo. B. !; iso JE!).

TURKEY. İçel: Güllek Tepe, *Siehe* 475.

**b.** subsp. **longiglume** Hausskn. in Mitt. Thür. Bot. Ver. n.f. 13:42 (1899)  
var. **longiglume**

Syn.: *Oryzopsis coerulescens* var. *grandis* Pampanini in Arch. Bot. (Forli) 2:20 (1936). Type: Libya, Cyrenaica (RO?—non vidi).

Type. Greece [prov. Argolis, Nauplion] in herbosis m. Palamidi supra Naupliam, *Haussknecht* (holo. JE—non vidi).

TURKEY. Gaziantep: Soff Da., 1250 m, *Hausskn.* 953.

LEBANON. Djebel Karnita, 1800 m, 12 vii 1934, *Zoh.* Around Sir, 930 m, 8 vii 1934, *Zoh.* Cedrus forest above Bscheria, 1500–1800 m, 21 vii 1931, *Eig* & *Zoh.* Wadi Zemerani, 1920–2020 m, 24 vi 1932, *Eig* & *Zoh.*

SYRIA. Above Ain Zahalta, 1200–1300 m, *Bornm.* 12928. About Damascus, 14 v 1931, *Zoh.*

ISRAEL. Upper Galilee: between Rosh-Pinna and Safad, 600 m, 23 iv 1962, *Zoh* & *Simchen*. Sharon plain: at Kabbara, 15 vi 1943, *Zoh.* Jerusalem, *Bornm.* 2687; 5 v 1952, *Zoh.* Mt. Ebal, *Davis* 4337 p.p. Judaeen mts.: Qiryat Anavim, 5 iv 1931, *Naftolsky*.

JORDAN. Between Ein Suela and Es-Salt, 14 iv 1929, *Eig* & *Zoh.*

IRAQ. Kuh Sefin at Arbil, 1200 m, *Bornm.* 1843, Penjwin, 1600 m, *R.* 12253. Pir Omar Gudrun, 1000–1600 m, *Hausskn.* 1015.

IRAN. Azerbaijan: 20 km S of Jolfa, 1350 m, 3 vii 1965, *Danin* & *Plitman*. Mazanderan: below Kondor, 1700 m, *Gaub* 1235. Kermanshah: Nawa Kuh, NW Karind, 2200 m, *Archibald* 1907. Luristan: Tang Malli, 2300 m, *Hausskn.* Arak: Sultanabad [Arak], 1890, *Strauss*. Fars.: Sabst Buschom near Shiraz, *Kotschy* 413, 745 p.p.

var. **epilosum** Freitag, var. **nov.** Differt lemmate omnino glabro. Differs in the completely glabrous lemma.

Type. Israel: Jerusalem, shaded by trees in yards, 20 v 1951, *Zohary* (holo. HUJ).

*P. holciforme* is well circumscribed by its tall growth, the large lax panicle with the longest branch reaching at least half of the panicle length, the pale spikelets, ovate lemma and long awn.

*P.* *Haussknecht* based his subsp. *longiglume* only on the longer glumes. However, the length of the lemma and awn are also useful characters, as may be seen from table 9, with the lemma dimensions as the most reliable one.

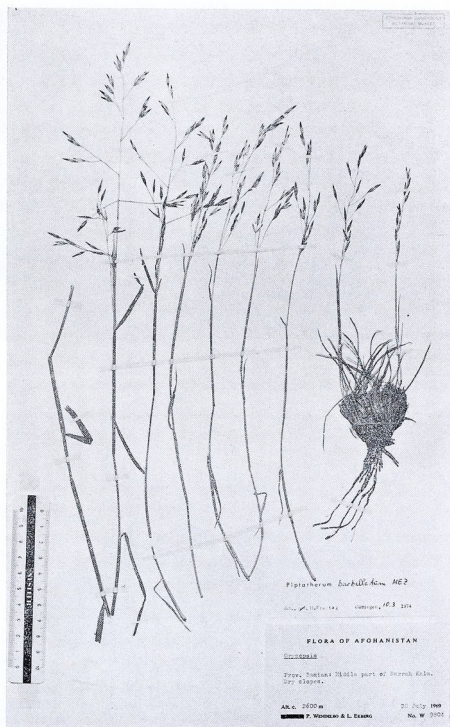


PLATE 4. Variability of panicle shape in a population of *Piptatherum barbellatum* Mez.





TABLE 9

Differential characters of the subspecies of *P. holciforme*

	ssp. <i>holciforme</i>	ssp. <i>longiglume</i>
Lemma, length in mm	(4.5-)5 - 6(-6.5)	(6.5-)7 - 8(-9)
Awn, length in mm	5 - 8	(7-)11 - 14(-18)
Spikelet, length in mm	(6-)7 - 10(-11)	(8.5-)9 - 14

The overlapping of the characters in the two subspecies is rather broad, and also geographically and ecologically they grade into each other. Subsp. *longiglume* is centred in the S and SE of the species area and represents the species exclusively in Syria, Lebanon and Palestine. But in Iraq and Iran both subspecies often grow, and have been collected, together. Judging from the description there is little doubt that *O. coerulescens* var. *grandis* Pampanini from Libya is identical with ssp. *longiglume*, as Maire (1952) already suggested.

*P. kopetdaghensis* Roshev. was retracted later on by the author himself (Roshevitz, 1951), and *P. karataviense* Roshev. has been reduced to synonymy by Tzvelev, 1968. The types have not been seen, but investigation of other material from the same regions led me to the same conclusion.

While this paper was in press, the first record of *P. holciforme* subsp. *holciforme* from Afghanistan came to light (*A.* 6814 cited above). In its narrow leaves (up to 4 mm), the presence of vegetative shoots, and the smaller lemmas (1.6-1.8 mm wide), the specimen clearly differs from *P. latifolium* which is also known from the same area. With this new find, the hitherto isolated outpost of *P. holciforme* in Kazakhstan becomes more understandable and probably the species has a scattered distribution in the wet mountainous area between NE Afghanistan and Kazakhstan. It seems likely that the record of *P. latifolium* var. *angustifolium* in *Flora Tadzhik*. (Ovchinnikov & Chukavina, 1957) is a misidentification of *P. holciforme*.

**8. *P. latifolium* (Roshev.) Nevski in Trudy Bot. Inst. Akad. Nauk SSSR 1:336 (1937).**

Syn.: *Oryzopsis latifolia* Roshev. in Komarov, Fl. URSS 2:743 (1934).

Type. USSR. Tadzhik SSR, distr. Chodshent, prope Ingyrtschak, in rupestribus, 8 v 1914, *Knorr* (holo. LE—non vidi).

In small, loose tufts or solitary, the thick base producing generative shoots only; culms (70-)90-120 cm, (4-)5(-6)-noded, with a decumbent base, glabrous; sheaths glabrous, the basal ones sometimes purplish; ligules 3-6 mm long, obtuse, often lacerated; blades flat, up to 30 cm × 6-15 mm, the upper surface glabrous, except the scaberulous apex, beneath grading from smooth to scaberulous in the middle part and scabrous near the apex; panicle lax, 15-25 cm long, 4-14 cm wide, the branches ascending to spreading, paired or up to 3, with the spikelets densely fascicled at their tips, scabrous, the longest at least half of the panicle; spikelets ovate, (7-)8-9(-10) mm long, the glumes with a green back and broad straw-coloured margins and tip, both glumes 7-9-nerved; mature lemma broad ovate, 4.5-5.5 × 2.0-2.5 mm. with an acute apex. as the palea covered by slightly ascending brownish hairs, the apex glabrous, the lower part of the back sometimes glabrescent, scar transversely elliptic to linear; awn (10-)12-15 mm long, (8-)9-12 mm exserted, terminal, somewhat irregularly bent, caducous; lodicules 1-1.2 mm long, roundish; anthers 2.2-2.7 mm

long, yellow, bearded; caryopsis ovoid to ellipsoid, dorsally slightly compressed, about  $3 \times 2$  mm, ratio embr.:car. = 1:3, hilum almost reaching the top. (Fig. 3h).

From Kopet Dagh in S Turkmenia through N Afghanistan, along the outer ranges of the Pamirs up to W Tianshan (fig. 10).

A rather rare species of the *Pistacia vera*- and lowermost *Juniperus seravschanica* woodlands from 1000–1600 m.

AFGHANISTAN. Badghys: 4 km E of Darra-e-Bum, 1100 m, *W.* 8167. Balkh: Ali Kuh, 18 km S of Mazar-e-Sharif, 1600 m, *W.* 8496. Badakhshan: Yawarzan, 30 km S of Qeshm, 1500 m, *W.* 9290.

Despite its close morphological and ecological affinity to *P. holciforme*, *P. latifolium* is a very distinct species, characterized by the extremely reduced basal branching, the absence of vegetative shoots, very broad leaves and the broadest lemma of the whole genus.

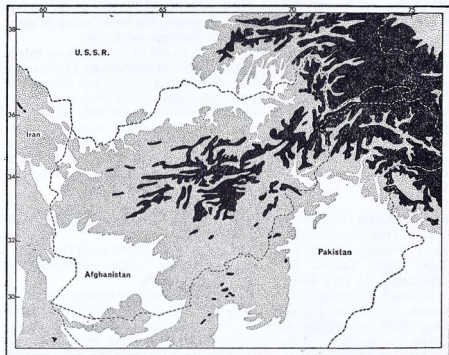


FIG. 5. Altitudinal map of Afghanistan and adjacent regions: stippled areas are between 1000 and 3000 m; black areas are over 3000 m.

9. *P. songoricum* (Trin. & Rupr.) Roshev. in Schischkin, Fl. Kirgiz. SSR 2:65 (1950).

Syn.: *Urachne songorica* Trin. & Rupr. in Mém. Acad. Imp. Sci. St. Pétersbourg 6, sér. 6:15 (1843).

*Milium holciforme* (M. Bieb.) Spreng. var. *songoricum* (Trin. & Rupr.) Griseb. in Ledeb., Fl. Ross. 4:446 (1853).

*M. coerulescens* Desf. var. *songoricum* (Trin. & Rupr.) Regel in Trudy Imp. S.-Petersburgsk. Bot. Sada 7:644 (1880).

? *M. coerulescens* var. *kokanicum* Regel, l.c. Type: USSR, C Asia: Zaravshankaja Dolina, Pachub, 1520 m, 6 vii 1870, Fedtschenko (holo. LE!).

*Oryzopsis songorica* (Trin. & Rupr.) B. Fedtsch., Rast. Turk. 94 (1915).

*O. holciformis* (M. Bieb.) Hack. var. *songorica* (Trin. & Rupr.) Roshev., Fl. Asiat. Russia 12:181 (1916).

*O. holciformis* var. *kokanica* (Regel) Roshev., l.c. 180.

*O. asiatica* Mez in Feddes Rep. 17:210 (1921). Type: USSR, Altai, Ehrenberg (B—destroyed).

*O. kokanica* (Regel) Roshev. in Komarov, Fl. URSS 2:742 (1934).

*Piptatherum kokanicum* (Regel) Roshev. in Schischkin, Fl. Kirgiz. SSR 2:66 (1950).

Type. USSR, C Asia: several syntypes from the Altai and Tarbagatai (LE—non vidi).

In small, dense tufts, with some generative and numerous vegetative shoots, branching intravaginal; culms (25-)30-60 cm, 2(-3)-noded, glabrous; sheaths glabrous; ligules at the culm leaves 4-7(-8) mm long, obtuse or acutish, often lacerated, at the vegetative shoots 2-4(-6) mm long, alike; blades flat or involute, at the culm leaves up to 12 cm  $\times$  3 mm, at the vegetative shoots up to 15 cm  $\times$  2 mm, upper surface glabrous or minutely pilose, near the apex scaberulous, beneath smooth near the base, grading into scaberulous or scabrous at the apex; panicle lax, (5-)10-20(-25) cm long,

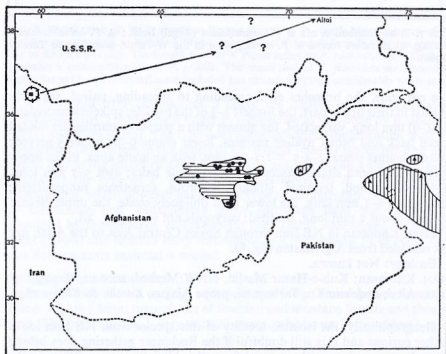


FIG. 6. Distribution of: ▲ *P. aequiglume* (Hook. f.) Roshev.; ● *P. barbellatum* Mez (total); ■ *P. songoricum* (Trin. & Rupr.) Roshev. The area of *P. aequiglume* extends to China. The question-marks refer to records of *P. songoricum* which may be misidentifications of the widespread C Asiatic *P. kokanicum*.

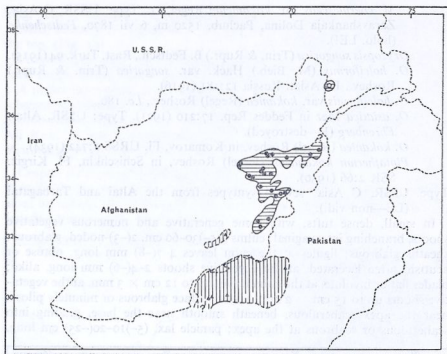


FIG. 7. Total distribution of: ● *P. angustifolium* (Regel) Boiss.; ▲ *P. baluchistanicum* Freitag; ○ literature record of *P. angustifolium* in the W Pamir, according to Tzvelev (1960).

2-9 cm wide, the branches erect-ascending to spreading, paired, scabrous at least in their upper part, the longest  $\frac{1}{2}$ - $\frac{3}{4}$  of the panicle; spikelets lanceolate, 6-8(-9) mm long, variegated, the glumes with a purple or purple-surrounded green back and broad hyaline margins, lower glume 6-7-, upper 5-nerved; mature lemma ovate, 4-4.5 × 1.3-1.6 mm, with an acute apex, in the upper half covered with slightly ascending short white hairs; awn 5-7 mm long, 3-5 mm exserted, terminal, straight, scabrous, sometimes subpersistent; lodicules 0.8-1 mm long, the lower ones obliquely ovate, the upper linear; anthers about 2 mm long, bearded; caryopsis not seen. (Fig. 3i).

From Khorasan in NE Iran through Soviet Central Asia to the Altai, not yet recorded from Afghanistan (fig. 6).

Ecology: Not known.

IRAN. Khorasan: Kuh-e-Hazar Masjid, NNW Meshed, 2000 m, *R.* 5059.

USSR. Altai, *Ledebour* s.n. Tarbagatai, prope Ajagus, *Karelin & Kirilov* 1840.

Geographically, the isolated locality of this species from NE Iran looks rather curious and it is still doubtful if the Rechingher gathering does belong here. In comparison with material from the Altai its lemma differs in the completely hair-covered apex.

The inclusion of *Oryzopsis asiatica* Mez in *P. songoricum* by Roshevitz (1951) seems to be justified even though the original description by Mez (1921) gives but scanty information about lemma characters.

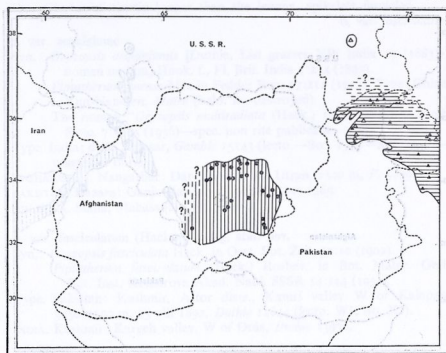


FIG. 8. Distribution of: ● *P. flaccidum* Freitag (total); ▲ *P. gracile* Mez. The area of *P. gracile* extends at least to Nepal. △ literature records of *P. gracile* from N Pakistan according to Kitamura (1964). The record from NW Pamir refers to *P. roshevitzianum* Tzvelev; probably a misidentification of *P. gracile*. The recent find of *P. flaccidum* var. *flaccidum* from Ghorat (*P.* 21953 in text) is not included but extends the range considerably westwards.

With regard to *P. kokanicum*, I share the doubts of Ovchinnikov & Chukavina (1957) in placing it under *P. songoricum* as was done by Roshevitz (1951) and Pazij (1968). The type does agree in lemma indumentum with *P. songoricum*, but differs in the shape of the lemma (clearly lanceolate and not ovate) and in the length of awn (3.5–4.1 and not more than 5 mm). In these characters the type of *P. kokanicum* comes closer to *P. flaccidum* from Afghanistan, which however has another type of indumentum. Furthermore, in Uzbekistan and Tadzhikistan other specimens have been collected, identified by Ovchinnikov & Tzvelev (in herb.) as *P. kokanicum*, with long awns (7 mm) and lemmas hairy throughout, e.g. Nazarenko 15 vi 1945. For clarification more material is needed.

#### Species-group 2 ('Lanceolata')

Lemma lanceolate in outline, awn 7–14 mm long. Three species from the Pamir Alai to China; mesophytes of lowland and montane forests and shrubland. The species form a very natural group, which can be considered as a series.

10. *P. aequiglume* (Hook. f.) Roshev. in Bot. Mater. Gerb. Bot. Inst. Komarov Akad. Nauk SSSR 14:113 (1951).

In large, loose tufts, with numerous generative and some vegetative shoots; branching extravaginal; culms (85–)90–130 cm, very stout, 4–5-noded,

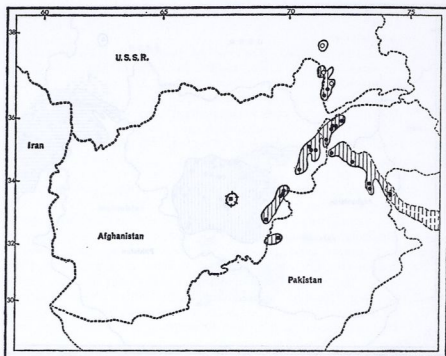


FIG. 9. Distribution of: ● *P. hilariae* Paziz; ■ *P. rechingeri* (Bor) Freitag (total). The area of *P. hilariae* extends a little further east. ○ literature records of *P. hilariae* from the Pamirs according to Ovchinnikov & Chukavina (1957).

scaberulous below the nodes; sheaths scaberulous in upper part, rather smooth below; ligules 4–7 mm long, obtuse to  $\pm$  acute, lacerated; blades flat, up to 30 cm  $\times$  5–7 mm, upper surface scaberulous, beneath scabrous; panicle lax (15–)20–30 cm long, (4–)10–20 cm wide, the branches spreading or ascending, the longest about  $\frac{1}{2}$  of panicle, branches paired or in whorls up to 5, scabrous; spikelets lanceolate, 6.5–8(–9) mm long, glumes with a green back and hyaline margins or purple-tinged, both glumes 5-nerved or the lower 7-nerved; mature lemma lanceolate, 5.6–5  $\times$  1.1–1.3 mm, with an acute apex, densely covered, as the palea, with erect to ascending, about 0.3 mm long brownish hairs, only the white apex glabrous; awn 8–11 mm long, terminal, straight, caducous to subpersistent; anthers 3.5–4 mm long, yellow, shortly bearded; lodicules 1.2–1.5 mm long, the lower ones lanceolate, the upper linear; caryopsis linear in outline, compressed, 3.6–3.9  $\times$  1.1–1.1 mm, ratio of embryo to caryopsis = 1:3, ratio of hilum to caryopsis about 9:10. (Fig. 3j).

From Nuristan in E Afghanistan through Kashmir along the Himalayas to China (fig. 6).

Very rare and restricted to the most mesophytic forests of *Quercus dilatata* and *Qu. semecarpifolia* from 2100–2500 m; in Kashmir in *Abies webbiana* and *Picea smithiana* forests up to 3300 m.

- 1a. Glumes as long as the lemma, spikelets loosely arranged .

a, var. *dequiglume*



- b. Glumes distinctly longer than the lemma, spikelets fascicled  
b, var. *fasciculatum*

a. var. *aequiglume*

Syn.: *Oryzopsis aequiglumis* [Duthie, List grasses NW India 27 (1883)—nomen nudum] Hook. f., Fl. Brit. India 7:234 (1897).

*Piptatherum sinense* Mez in Feddes Rep. 17:211 (1921). Type: China, Yun-Nan-Sen, Maire (holo. B—destroyed).

The nomen "*Oryzopsis multiradiata* (Hack.) Hand.-Mazz.", Symb. Sinic. 7:1295 (1936)—spec. non rite publicata—refers.

Type. India: distr. Jaunsar, Gamble 15143 (lecto.—Bor, 1970—K!; iso. Z!—vegetative only).

AFGHANISTAN. Nangarhar: Dar-e-Nur above Utran, 2300 m, F. 5949.

PAKISTAN. Hazara: Ganja Kandao, 2200 m, Burt 1265.

NW INDIA. Simla, Mahassoo, 1852, Thoms.

b. var. *fasciculatum* (Hack.) Freitag, stat. nov.

Syn.: *Oryzopsis fasciculata* Hack. in Oest. Bot. Zeit. 52:10 (1902).

*Piptatherum fasciculatum* (Hack.) Roshev. in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 14:114 (1951).

Type. Pakistan: Kashmir, Astor distr., Kamri valley W of Kalapani, 3050–3350 m, 25 viii 1892, Duthie 12644 (lecto. W!; iso. K!).

INDIA. Kashmir: Kargah valley, W of Drás, Duthie 13936.

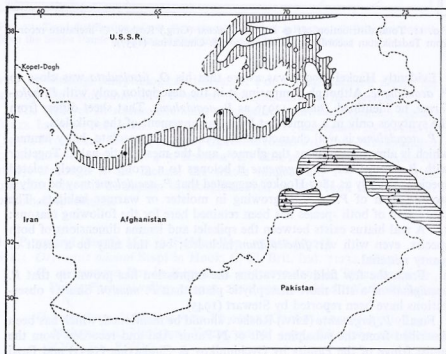


FIG. 10. Distribution of: ● *P. latifolium* (Roshev.) Nevski; ▲ *P. munroi* (Stapf) Mez. The area of *P. munroi* extends to China, that of *P. latifolium* to the Tianshan. ○ literature records of *P. latifolium* from the Kopet Dagh according to Roshevitz (1951) and from Tadjikistan according to Ovchinnikov & Chukavina (1957).

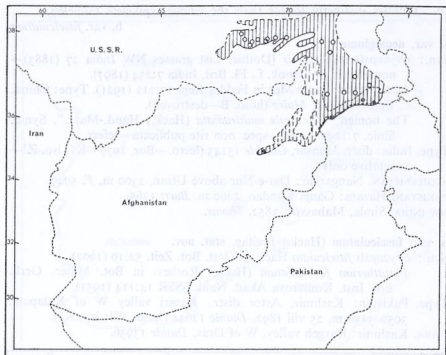


FIG. 11. Total distribution of: ● *P. pamiralaicum* (Grig.) Roshev. ○ literature records from Tadjikistan according to Ovchinnikov & Chukavina (1957).

Evidently Hackel (1902) was aware that his *O. fasciculata* was close to *P. aequiglume*. Although comparing it in the description only with *P. holciforme*, he identified Duthie 13936 as *P. aequiglume*. That sheet differs from the syntypes only in a somewhat looser arrangement of the spikelets.

*P. aequiglume* is well characterized by the long, lanceolate, hairy lemma, which is almost as long as the glumes, and the mesophytic habit. Together with *P. munroi* and *P. ferganense* it belongs to a group of closely related species. As early as 1897 Hooker suggested that *P. aequiglume* may be only a stouter form of *P. munroi*, growing in moister or warmer habitats. The separation of both species has been retained here for the following reasons:

1. A real hiatus exists between the spikelet and lemma dimensions of both species, even with var. *fasciculatum* included; but this may be a result of scanty material.
2. From the few field observations the impression has grown up that *P. aequiglume* is a still more mesophytic plant than *P. munroi*. Similar observations have been reported by Stewart (1945).

Finally *P. ferganense* (Litv.) Roshev. should be mentioned, which has been described from the subalpine belt of N-Pamir Alai and recorded from the moist fringe of the Pamirs by Ovchinnikov & Chukavina (1957) and Pazij (1968); the citation from Kopet Dag seems dubious. This species may be found in Afghanistan—at least in N Badakhshan. Investigation of the type (Litvinov, LE!) has shown that in lemma and spikelet characters it is identical with *P. aequiglume*. The contracted panicle has been found as the only, not

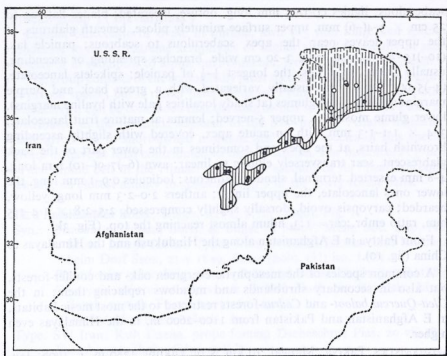


FIG. 12. Total distribution of: ● *P. purpurascens* (Hack.) Roshev. ○ literature records from the Soviet Pamir according to Ovchinnikov & Chukavina (1957).

very convincing, morphological difference. For a final decision about the appropriate taxonomic rank, however, too little material has been seen.

The types of *P. sinense* Mez and *Oryzopsis multiradiata* (Hack.) Hand.-Mazz. have not been seen. They were included in *P. aequiglume* by Roshevitz (1951). From their descriptions they represent forms with the lower branches of the panicle in whorls of 4-5. Because very little material was available for study, although it did include the whole range from 1-5 basal panicle branches, there is no reason to recognize even varietal rank for the richer branched specimens.

**11. *P. munroi* (Stapf) Mez in Feddes Rep. 17:212 (1921).**

Syn.: *Oryzopsis munroi* Stapf in Hook. f., Fl. Brit. Ind. 7:234 (1897).

*O. stewartiana* Bor in Kew Bull. 1953:272 (1953). Type: India or., Pulga, Parbatti valley, 2000 m, 22 vii 1935, Mahinder Nath 988 (holo. K!).

*O. geminiramula* Ohwi in Acta Phytotax. Geobot. 17:14 (1957). Type: Afghanistan, Nuristan, Voma, 20 vii 1955, Kitamura 168 (holo. KYO; iso. KYO!).

Type. NW India: Chenab Himalayas, 1852, Thomson (lecto. E!).

In rather large, loose tufts, usually with numerous generative and some vegetative shoots, branching extravaginal, basal nodes somewhat elongated, culms (30-)50-90(-120) cm, (3-)4(-5)-noded, glabrous; sheaths glabrous or

scaberulous; ligules (1-)2-5 mm long, obtuse, lacerated; blades flat, up to 25 cm  $\times$  3-4(-6) mm, upper surface minutely pilose, beneath glabrous, at the upper leaves near the apex scaberulous to scabrous; panicle lax, (10-)15-30(-35) cm long, 3-20 cm wide, branches spreading or ascending, usually paired, scabrous, the longest  $\frac{3}{4}$ -1 of panicle; spikelets lanceolate, (4-)5-6(-7) mm long, usually variegated with a green back and purple margins and tip of the glumes (at shady localities pale with hyaline margins), lower glume mostly 7-, upper 5-nerved; lemma at mature fruit lanceolate, 3-4  $\times$  1.1-1.3 mm with an acute apex, covered with slightly ascending brownish hairs, at the apex and sometimes in the lower part of the back glabrescent, scar transversely elliptic to linear; awn (6-)7-9(-10) mm long, 4-8 mm exserted, terminal, slender, caducous; lodicules 0.9-1 mm long, the lower ones lanceolate, the upper linear; anthers 2.0-2.3 mm long, yellow, bearded; caryopsis ovoid, dorsally slightly compressed, 2.5-2.8  $\times$  1.4-1.5 mm, ratio embr.:car.=1:3, hilum almost reaching the top. (Fig. 3k).

From Paktya in E Afghanistan along the Hindukush and the Himalayas to China (fig. 10).

A common species of the mesophytic evergreen oak- and conifer-forests, but also in secondary shrublands and meadows replacing them; in the *Olea-Quercus baloot*- and *Cedrus*-forests restricted to the most mesic habitats, in E Afghanistan and Pakistan from 1100-2600 m, in the Himalayas even higher.

AFGHANISTAN. Paktya: Mangal, 10 km N of Yakubi, 1380 m, *F.* 1906; Jaji, around Kotgay, 2500-2600 m, *F.* 1810. Nangarhar: Dar-e-Nur, 1700 m, *F.* 5899; *ibid.*, 1900 m, *F.* 5901, 5912. Kunar: Gusalak, *Neub.* 814.

PAKISTAN. Swat: between Barikot and Mingora, 700-900 m, *R.* 30485. Kalam, 2200 m, *R.* 19452, 19408. Hazara: NE of Abbottabad, Nathiagali road, *Burt* 540.

INDIA. Kashmir: Tangmarg, 2000 m, *Polunin* 56/461; Pir Panjal pass, 3500 m, 2 viii 1875, *Leringe*. Himachal Pradesh: Pangi Chamba, near Kilur, 2700 m, *Watt* 123, 145, 176; Bashar, Jeedong forest, 3100 m, *Lace* 595. Uttar Pradesh: Dunna hill, 14 viii 1881, *Fleming*.

The species is easily recognised by its lax panicle, lanceolate and hairy lemma and the long awn. Variability is rather little except for occasional specimens with a tendency to fascicled arrangement of spikelets, e.g., *Polunin* 56/461 from Kashmir. The affinities to the related *P. dequighume* and *P. ferganense* are discussed under sp. no. 10. *P. tibeticum* Roshev. and *Oryzopsis stewartiana* Bor differ from normal *P. munroi* essentially only in their smaller spikelets. When more material is at hand it may be possible to give this delicate form some infra-specific rank.

From the description and illustrations of *O. geminiramula* in Kitamura (1960) it can be concluded that the type is a perfectly normal individual of *P. munroi*, as Bor (1970) has already suggested. The isotype material confirms this view.

From the rich and homogeneous syntype material, a Thomson gathering has been chosen as lectotype.

Records of *P. munroi* from Iran and C Afghanistan (Bor 1970) are based on false identifications.

## Species-group 3 ('Breviaristata')

Lemma lanceolate or ovate in outline, awn 1–5 mm long. Ten species; moderate to rather extreme xerophytes of higher altitudes, usually in semi-deserts or in subalpine to alpine environments; from E Anatolia to Nepal.

The group consists of the ecologically most specialized and morphologically advanced species but is rather heterogeneous. From lemma-shape and other characters it can be concluded that the long awned species—groups 1 and 2—distributed in the lowlands adjacent to the SW- and C- Asiatic highlands, have given rise to short-awned montane and alpine species of this species-group or have at least contributed to their evolution. For instance, *P. gracile* of the alpine belt in the Himalayas has, on account of its linear-lanceolate lemma, its closest affinity to species-group 2 of the lower forest belts.

**12. *P. molinioides* Boiss., Diagn. sér. 1, 7:121 (1846). Fig. 1.**

Syn.: *Urachne sphacelata* Boiss. & Buhse in Nouv. Mém. Soc. Imp. Nat. Mosc. 12:230 (1860). Type: Iran, zwischen Isfahan und Kaschan, beim Dorf Ssou, 21 v 1849, *Buhse* (holo. G!; iso. LE!).

*Piptatherum sphacelatum* (Boiss. & Buhse) Boiss., Fl. Or. 5:508 (1884).

*Oryzopsis sphacelata* (Boiss. & Buhse) Hack. in Vidensk. Medd. dansk. naturh. Foren. 1903:165 (1903).

*O. molinioides* (Boiss.) Hack., l.c.

Type. SW Iran: Kuh Daena, prope fontem Dscheschme Pias, 29 vii 1842, *Kotschy* 755a (holo. G!; iso. K!).

Densely tufted, with numerous vegetative and some generative shoots, branching intravaginal; culms (15–)30–60(–80) cm, (2–)3–4-noded, glabrous; sheaths glabrous; ligules at the culm leaves (2–)3–6(–7) mm long, obtuse to acutish, at the vegetative shoots 2–4 mm long, usually obtuse, often lacerated; blades greyish-green, flat or involute, at the culm leaves up to 7(–12) cm × 1.5–2.5(–2.8) mm, at the vegetative shoots longer and narrower, upper surface pilose, beneath scaberulous grading into scabrous towards the apex; panicle lax or contracted, (4–)7–13(–19) cm long, (1–)2–6(–8) cm wide, the branches erect or ascending, rarely spreading, paired or solitary, glabrous or scabrous, the longest  $\frac{1}{3}$ – $\frac{1}{2}$  of the panicle; spikelets lanceolate, (6.5–)7–9(–10) mm long, glumes with a green back and yellow rims and tip, or with a purple tip, rarely purplish throughout, lower glume 5–7-nerved; lemma at mature fruit narrow-ovate to lanceolate, (4.3–)5–6(–6.2) × (1.2–)1.3–1.4(–1.6) mm, with an acute apex, in the upper  $\frac{1}{2}$  or  $\frac{1}{3}$  very densely covered by 0.3–0.5 mm long white to brownish hairs, exceeding the apex, the dorsal line often glabrescent, the lower part of the back glabrous or glabrescent, scar transversely elliptic to linear; awn (2.5–)3–4.5(–5) mm long, up to 3 mm exerted, terminal, slightly bent, caducous; lodicules 0.9–1.1 mm long, the lower ones lanceolate, the upper almost linear; anthers 2.5–3.5 mm long, yellow or purplish, unbearded or with very few short apical hairs; caryopsis ellipsoid, dorsally slightly compressed, 3.2–3.5 × 1.3 mm, ratio embr.:car. = 1:3, hilum almost reaching the top (fig. 31).

Endemic to Iran (fig. 17).

According to the very sparse ecological records, this is a species of xerophytic woodlands and of semideserts. Boissier & Buhse (1860) mention a community with *Zygophyllum eurypterum* and *Ephedra alata* in the mountains of inner Iran at medium altitudes from 1900–2700 m.

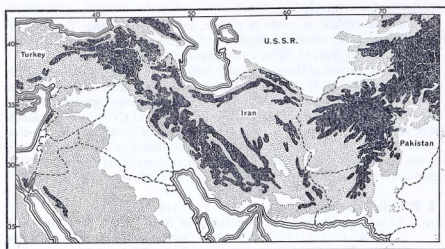


FIG. 13. Altitudinal map of part of SW Asia: stippled areas are between 500 and 2000 m; black areas are over 2000 m.

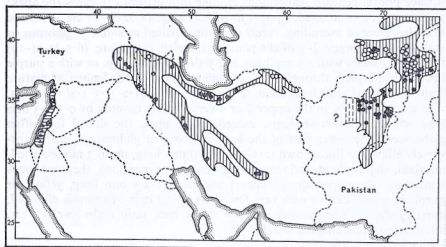


FIG. 14. Distribution of:  $\blacktriangle$  *P. blanchenaeum* [Desv. ex] Boiss. (total);  $\bullet$  *P. laterale* (Regel) Roshev. The area of *P. laterale* extends to the Tianshan. Literature records of  $\triangle$  *P. blanchenaeum* according to Mouterde (1966) and of  $\circ$  *P. laterale* according to Ovchinnikov & Chukavina (1957).



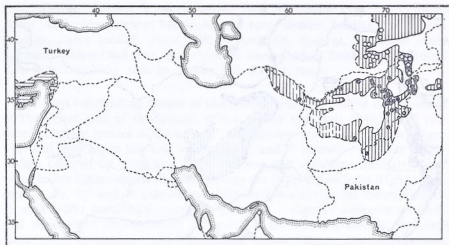


FIG. 15. Distribution of:  $\Delta$  *P. coerulea* (Desf.) P. Beauv.;  $\bullet$  *P. vicarium* (Grig.) Roshev. *P. coerulea* extends to Macaronesia, *P. vicarium* to the Tianshan. Literature records of  $\Delta$  *P. coerulea* according to Holmboe (1914) and  $\circ$  *P. laterale* from Ovchinnikov & Chukavina (1957).

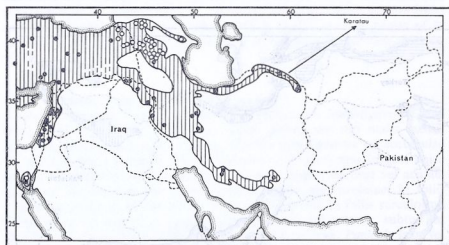


FIG. 16. Distribution of:  $\bullet$  *P. holciforme* (M. Bieb.) Roem. & Schult. The area extends to the Balkan peninsula and Libya.  $\circ$  literature records according to Grossheim (1939) and Täckholm (1941). The recent find of *P. holciforme* subsp. *holciforme* from Afghanistan is not included (see text); nor is the record of *P. holciforme* subsp. *longiglume* from Gaziantep in Turkey.

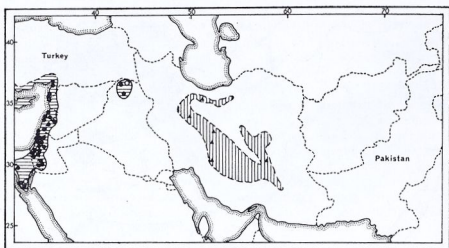


FIG. 17. Distribution of: ● *P. miliaceum* (L.) Coss.; ▲ *P. molinioides* Boiss. (total). The area of *P. miliaceum* extends to Macaronesia. ○ literature records of *P. miliaceum* from Iraq according to Bor (1968).

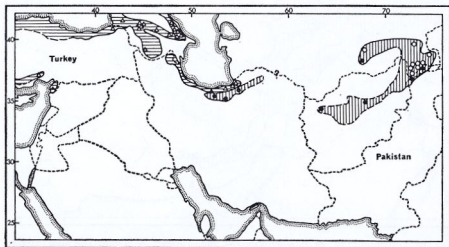


FIG. 18. Distribution of: ● *P. platyanthum* Nevski (total); ▲ *P. virescens* (Trin.) Boiss. *P. virescens* extends to S France. ○, △ literature records of *P. platyanthum* and *P. virescens* according to Boissier (1884), Bor (1970) and Grossheim (1939).

IRAN. Tehran: Keredj, Kuh Dscharru, 1900 m, *Gaub* 1755; 20 vi 1940, *Parsa*. Arak: Nowedere at Sultanabad, vi 1904, *Strauss*. Isfahan: Schahreza, 2140 m, *Pabot* 10068E. Fars: NW of Ardekan, 2740 m, *Archibald* 2898. Kerman: Kuh-e-Dschupar, 2700–3600 m, *Bornm.* 4844. Bakhtiari: Oshtoran Kuh (Shuturunkuh), 2000 m, *Bowles Sch. Exped.* 729.

The most outstanding feature of this species is the very dense indumentum of the upper part of the lemma, which clearly separates it from the two other common species of the area: *P. holciforme*—with, moreover, a longer awn and growing in less arid regions only, and *P. laterale*—with the whole lemma covered by hairs and only in alpine and subalpine habitats. Taxa with similar lemma characters and ecology are *P. flaccidum* from Afghanistan (see sp. no. 13) and *P. songoricum*. Although Boissier in the description of *P. molinioides* mentioned correctly “glumeis . . . superne adpresse sericeis” and maintained that essential statement in the *Flora Orientalis*, he cited there some gatherings with a complete, looser lemma indumentum and reduced *P. laterale*, which is based just on such specimens, to synonymy. He was followed by most authors except Roshevitz (1951). Re-investigation of the broader range of material available today convinced me of the specific rank of both species. Further criteria beside the indumentum of the lemmas are the anthers, always bearded in *P. laterale* and glabrous in *P. molinioides* and their different ecology: *P. molinioides* being a species of medium altitudes, and *P. laterale* of alpine and subalpine habitats.

With respect to *P. sphacelatum*, Boissier mentioned as differences the spike-like inflorescence and the convolute leaves in *P. molinioides*, but these characters have very limited value (see p. 349, 350). Furthermore, both species have been placed in different groups according to the lemma shape. Whereas the type of *P. sphacelatum* has narrow ovate lemmas, the type of *P. molinioides* has lanceolate lemmas. These characters are indeed highly important (see p. 351), but as the material of *P. sphacelatum* contains almost mature fruits and therefore the lemmas have reached their final shape, the plants of *P. molinioides* have just passed anthesis and the lemmas are at their smallest width.

### 13. *P. flaccidum* Freitag, sp. nov. (plate 5A).

Gramen perenne, dense caespitosum, ramificatione intravaginali. Culmi (15–)25–60(–75) cm alti, 3–4-nodes, laeves glabri, sed sub nodis mediis interdum dense pubescentes. Vaginae foliorum laeves glabrae vel scaberulae vel pubescentes. Ligulae in foliis culmorum (2–)3–5(–7) mm longae, apice acutae, in foliis surculorum basaliu 2–4 mm longae, obtusae vel acutae, interdum incisae. Laminae cinereo-virides, planae vel involutae, in foliis culmorum usque ad 8(–10) cm × (1.3–)1.5–2(–3) mm, in foliis surculorum basaliu ad 15(–25) cm × (1.0–)1.2–2 mm, supra pubescentes, subtus aut glabrae aut scaberulae vel pubescentes, margine scabrae. Panicula laxa vel contracta, flaccida, (4–)8–20(–22) cm longa, 1–5(–10) cm lata; axis primarius sub panicula et inter ramificationes infimas plerumque flexuosus; rami erecti vel ascendentes vel raro patentes, filiformes, bines vel singulares, glabri aut scabri, ramo longissimo longitudine  $\frac{3}{4}$ – $\frac{1}{2}$  paniculae aequans. Spiculae lanceolatae, 6–10(–11) mm longae; glumae hyalinae non nisi supra

base pallide virides vel diluto purpureae, 5-7-nerves. *Lemma* lanceolatum vel lineare, (3.8-4.5-5.5(-6.5)  $\times$  0.8-1.2 mm, coriaceum, brunneum, in parte superiore ( $\frac{1}{2}$ - $\frac{3}{4}$ ) pilis infuscatis ascendentibus 0.3-0.5 mm longis apicem superantibus tectae, supra nervum dorsalem usque ad apicem glabratum, cicatrix transverse elliptica vel linearis; arista (1.5-2-4(-4.5) mm longa, inclusa vel usque ad 0.5(-1) mm exserta, terminalis, recta, scabra, caduca, *Palea* lemma subaequans. *Lodiculae* 3, 0.8-1 mm longae, inferiores ovatae, summa fere linearis, omnes apice obtusae. *Stamina* 3; antherae 2.5-3.5(-4) mm longae, luteae vel purpureo-tinctae, saepe apicis breve barbatae. *Caryopsis* ellipsoidea, dorso leviter complanata, 3.0-3.2  $\times$  1.0-1.3 mm, scutello  $\frac{1}{2}$  caryopsis aequante, hilo lineari apicem fere attingenti.

Densely tufted, with numerous generative and vegetative shoots, branching intravaginal; culms (15-)25-60(-70) cm, 3-4-noded, glabrous or retrorsely pubescent below the middle nodes; sheaths glabrous, scaberulous or pubescent; ligules at the culm leaves (2-)3-5(-7) mm long, acute, at the vegetative shoots 2-4 mm long, obtuse or acutish, often lacerated; blades flat or involute, greyish-green, at the culm leaves up to 8(-10) cm  $\times$  (1.3-) 1.5-2(-3) mm, at the vegetative shoots up to 15(-25) cm  $\times$  (1.0-)1.2-2(-2.5) mm, upper surface densely pilose, beneath either glabrous grading into scaberulous at the apex, or scaberulous or pubescent; panicle lax or contracted, flaccid, usually variously bent, (4-)8-20(-22) cm long, 1-5(-10) cm wide, the main axis flexuose below and above the lowermost branches, the branches erect or ascending, rarely spreading, paired or solitary, glabrous or scabrous, very slender, the longest  $\frac{1}{3}$ - $\frac{1}{2}$  of the panicle; spikelets lanceolate, 6-10(-11) mm long, pale, glumes with a green back and broad and long hyaline margins and tip, sometimes the back purplish tinged, lower glume 5-7-nerved; upper glume 5-6-nerved; lemma at mature fruit lanceolate to almost linear in outline, (3.8-)4-5.5(-6.5)  $\times$  0.8-1.2 mm, the upper  $\frac{1}{2}$  covered by 0.3-0.5 mm long ascending brownish hairs distinctly exceeding the apex, with the dorsal line eventually glabrescent, scar transversely elliptic to linear; awn (1.5-)2-4(-4.5) mm long, included or up to 0.5(-1) mm exserted, terminal, straight, caducous; lodicules 0.8-1 mm long, the lower ones ovate, the upper narrower, all 3 with obtuse apices; anthers 2.5-3.5(-4) mm long, yellow or purplish, often but not always bearded; caryopsis ellipsoid, dorsally slightly compressed, 3.0-3.2  $\times$  1.0-1.3 mm, ratio embr.: car. = 1:3, hilum almost reaching the top (fig. 3m). Endemic to C and E Afghanistan (fig. 8).

Rather common in different types of open woodland (*Pistacia atlantica*, *Amygdalus kuranica*, *Pinus gerardiana*, *Juniperus seravschanica*) and in open seral communities, extending also into montane semi-deserts; extending from the montane to the subalpine belt, between 2100 and 3300 m.

- 1a. Internodes, sheaths and blades glabrous or scaberulous a, var. *flaccidum*
- b. Internodes, sheaths and blades densely pubescent . b, var. *pubescens*

#### a. var. *flaccidum*

Type. Afghanistan. Bamyān: Panjao, in vicinity of village, on rocky limestone slopes, 2700 m, 1 vii 1962, *Hedge & Wendelbo* W. 4931 (holo. E!; iso. K! BG!).

AFGHANISTAN. Bamyan: Panjaw, 20 km SW, 2500 m, *R.* 36543; Band-e-Amir, at lake Zolfikar, 2900 m, *R.* 18412; Kulloo pass between Kabul and Bamyan, *Griff.* 102. Maydan: Khash Kul bridge at Hilmand river, 2560 m, *W.* 8679. Ghazni: E margin of Dasht-e-Nawur, Bini Darzak pass, 3000 m, *A.* 3977, *F.* 1438 p.p.; Ghouch pass NNE Sang-e-Masha, 3300 m, *R.* 17651. Kabul: Paghman mts. above Razak, 2500 m, *F.* 1011. Logar: at Pul Alam, 2150 m, *F.* 965; Shutur Gardan pass, 3250 m, *F.* 5755. Paktya: Altimur pass, N Gardez, 2850–3200 m, *R.* 21831. Urozgan: 15 km SSW at road to Tirin, 2100 m, *F.* 923. Ghorat: Sharak, 16 km WSW, 2400 m, *P.* 21953.

**b. var. pubescens Freitag, var. nov.**

Differt laminis vaginisque et internodiis dense pubescentibus.

Type. Afghanistan. Parwan: Surkh-e-Parsa, 10 km from Ghorband valley, 2150 m, in gorge, on semi-desert slopes, 27 vi 1967, *Freitag* 1160 (holo. GOET).

AFGHANISTAN. Bamyan: base of Mullah Yakub pass at road Behsud-Panjaw, 2500 m, *F.* 6325; Kalu valley between Bamyan and Hajigak pass, 2700 m, *F.* 6389, 6408. Parwan: below Shibar pass, 2200 m, *V.* 469. Maydan: Tschahevardak, Koh Gaworgin S of dam, 2950 m, *Gilli* 423.

The new endemic species is best characterized by its flaccid, usually lax panicle, the hyaline spikelets and the lemma indumentum of antrorse brown hairs exceeding the apex and restricted to the upper part of the lemma. In the latter respect it is very similar to *P. molinioides* but the panicle and spikelet structure are completely different. Otherwise, in the latter features *P. flaccidum* comes rather close to the type of *P. kokanicum* (see sp. no. 9), but the awn is shorter and the lemma indumentum is longer. All three taxa resemble each other ecologically; they replace *P. laterale* at medium altitudes and advance far into semi-desert communities. Somewhat similar to our new species is *P. baluchistanicum* from adjacent parts of W Pakistan, but that species always has ovate lemmas with completely glabrous apices. Var. *pubescens* is confined to montane semi-desert regions.

In addition to var. *pubescens* it seems possible that, with more material, another infra specific taxon might become apparent: plants from the E and SE of Afghanistan (Logar, Paktya, Ghazni) have smaller panicles, spikelets and lemmas.

Bor (1970) cited specimens of *P. flaccidum* under four different names: *Oryzopsis lateralis*, *O. brachyclada*, *O. pubiflora*, and even *O. holciformis*.

**14. P. baluchistanicum Freitag, sp. nov. (plate 5B).**

Type. Pakistan: Hanna valley near Quetta, 4 v 1888, *Lace* 3780 (holo. K!; iso. E!—3 sheets).

Gramen perenne, caespites parvos et densos formans, ramificatione intravaginali. Culmi (12–)25–50(–60) cm alti, (2–)3(–4)-nodes, laeves, glabri. Vaginae foliorum in parte infima glabrae, in parte superiore scaberulae vel pubescentes. Ligulae in foliis culmorum (2–)3–4(–5) mm longae, apice obtusae, in foliis surculorum basalium 2–3(–4) mm longae, interdum laceratae. Laminae cinereo-virides, planae vel involutae, supra dense pubescentes, subtus glabrae vel scaberulae, apice et margine scabrae, in foliis surculorum basalium ad 15 cm longae, 1–1.5(–2) mm latae. Panicula laxa, erecta,



(5)9-15(-20) cm longa, (2-)3-7 cm lata; rami ascendentes vel patentes, filiformes, recti, singulari vel bines, raro verticillati terni vel quaterni, ramo longissimo longitudine  $\frac{1}{2}$  paniculae vix aequans. *Spiculae* ovatae, (4.5-)5-7(-7.5) mm longae, variegatae, glumae dorso pallide virides, margine et apice purpureae, 5-6-nerves. *Lemma* ovatum, apice acutum, (3.2-)3.5-4.5  $\times$  1.3-1.5 mm, coriaceum, brunneum, praeter apicem pilis rectis albidis ascendentibus 0.2-0.3 mm longis laxe tectum, supra nervum dorsalem in dimidio inferiore glabratum, cicatrice elliptica. *Arista* (2-)3-4 mm longa, (0.5-)1-2.5(-3) mm exserta, terminalis, recta, scabra, caduca. *Lodiculae* 3, 0.8-1 mm longae, inferiores ovatae, summa linearis. *Stamina* 3; antherae 2-2.5 mm longae, luteae, apicibus breve barbatae vel pilosae. *Caryopsis* ovoidea, dorso leviter complanata, 2.6-2.9  $\times$  1.3-1.5 mm, scutello  $\frac{3}{4}$  caryopsis aequante, hilo lineari apicem fere attingenti (fig. 3n).

In small, dense tufts, with some generative and numerous vegetative shoots, branching intravaginal; culms (12-)25-50(-60) cm, (2-)3(-4)-noded, glabrous; sheaths glabrous in their lowermost part, grading into scaberulous and scabrous, sometimes even pilose, in their upper part; ligules of the culm leaves (2-)3-4(-5) mm long, obtuse, lacerated, at the vegetative shoots 2-3(-4) mm long; blades flat or involute, greyish, at the culm leaves up to 5(-7) cm  $\times$  1.5-2(-2.5) mm, at the vegetative shoots up to 15 cm  $\times$  1-1.5(-2) mm, the upper surface densely pilose, beneath usually papillose to tuberculate, smooth, only towards the apex scabrous; panicle usually lax, (5-)9-15(-20) cm long, (2-)3-7 cm wide, the branches ascending to spreading, paired or solitary, rarely up to 4, scabrous, at least in their upper part, the longest hardly reaching  $\frac{1}{2}$  of panicle length; spikelets ovate, (4.5-)5-7(-7.5) mm long, variegated, the glumes with a green back and narrow purplish margins and tip, the lower (5-)6-nerved, the upper 5-nerved; lemma at mature fruit ovate in outline, (3.2-)3.5-4.5  $\times$  1.3-1.5 mm, with an acute apex, covered with slightly ascending, white, 0.2-0.3 mm long white hairs, except for the apex, along the dorsal line in the lower part usually glabrescent; scar transversely elliptic; awn (2-)3-4 mm long, (0.5-)1-2.5(-3) mm exserted, terminal, straight, caducous; lodicules 0.8-1 mm long, the lower ones ovate, the upper linear; anthers 2-2.5 mm long, yellow, bearded or at least with 1-2 short apical hairs; caryopsis ovoid, dorsally slightly compressed, 2.6-2.9  $\times$  1.3-1.5 mm, ratio embr.:car. = 3:7, hilum almost reaching the top.

Endemic to the area from Quetta to the Sulaiman mts. in W Pakistan and adjacent SE Afghanistan (fig. 7).

Rather rarely collected, but locally abundant and probably more common in medium altitudes between 1700-2700 m; in Baluchistan reported mainly from the *Juniperus* belt; in SE Afghanistan in deciduous woodlands with *Amygdalus kuramica* and *Fraxinus xanthoxyloides*.

AFGHANISTAN. Ghazni: Moqur, 20 km SW above Agodhjan, 2450 m, *F.* 3431. PAKISTAN. Baluchistan, *Lace* 3857, 3750. Quetta: Spin Karez, 1800-1900 m, *R.* 29245. Shinghar, *Norris* 182. Urak gorge, 2000 m, *Stew.* 27960; v 1958, *Repp*; Ziarat, 2600 m, *Stew.* 27953, 27956. Between Bostan and Saran Tangai, 55 km from Quetta, 1700-1800 m, *Diamond* 1110. Between Fort Sandeman and Dera Ismael Khan, 1750-1900 m, *R.* 29919.

In habit and in ecology the new species closely resembles *P. hilariae*, but is clearly distinct in the absence of apical lemma lobes and the terminal position of the awn. The closest relative is perhaps *P. munroi*, as indicated by the size of the lemma, type of lemma indumentum and the mode of panicle branching. Nevertheless, it is well separated by the much shorter awn, the smaller size of the plant and its pronounced xerophytic character. Speculating about the natural affinities of the new species is very difficult. It should be emphasised that the distinctly ovate lemma may indicate derivation from species-group 1 ('Ovata'), but at least as far as their distributions are currently known, the areas of both taxa are distinct. In Bor's *Flora Iranica* account (1970) specimens belonging to *P. baluchistanicum* were named either *O. wendelboi*, *O. gracilis*, *O. pubiflora*, *O. munroi* or *O. sphacelata*.

**15. *P. barbellatum* Mez in Feddes Rep. 17:211 (1921). Plate 4.**

Syn.: *Oryzopsis barbellata* (Mez) Bor in Biol. Skr. 14.4:78 (1965).

Type. Afghanistan: Yonutt [between Unai pass and upper Hilmand valley], Griffith 997 (Journal) (lecto. K!; isolecto. E!, LE!).

In small, dense tufts, with some generative and numerous vegetative shoots, branching intravaginal; culms (10-)25-50(-60) cm tall, 2-4-noded, glabrous; sheaths glabrous to scaberulous; ligules at the culm leaves (1.5-)2-4(-8) mm long, acute, at the vegetative shoots 1-3 mm long, obtuse to acute; blades greyish green, flat or involute, culm leaves up to 7 cm  $\times$  0.8-2(-4) mm, at the vegetative shoots somewhat longer, 0.8-1.3(-1.5) mm wide, upper surface pilose, beneath scaberulous grading into scabrous towards the apex; panicle usually contracted, but sometimes lax, (4-)6-12(-13) cm long, (0.5-)1-3(-11) cm wide, the branches erect or ascending, rarely spreading, solitary or paired, rarely whorled up to 4, glabrous to scabrous, the longest  $\frac{1}{2}$ - $\frac{3}{4}$  of panicle length; spikelets lanceolate, (6-)7-9(-10) mm long, glumes usually with a green back, yellow rim and purple tip, more rarely purplish or pale throughout, lower glume (3-)5-7-nerved, upper glume 3-5-nerved; lemma almost linear, at mature fruit (3.8-)4.3-5(-6)  $\times$  0.8-1.1 mm, at the apex densely covered by short and thick hairs with rounded tips, otherwise glabrous, scar transversely elliptic to linear; awn (1.5-)2-2.5(-3) mm long, included or up to 1 mm exerted, terminal, straight, caducous; lodicules 0.8-1 mm long, the lower ones almost elliptic, the upper linear to lanceolate; anthers 2.5-3(-3.7) mm long, yellow or purple, bearded at the apex or at least with scattered apical hairs; caryopsis narrow elliptic in outline, dorsally flattened, about 3.5  $\times$  1.1 mm, ratio embr.:car. = 1:4, hilum almost reaching the apex (fig. 3,0).

Endemic to C and E Afghanistan (fig. 6).

A very common species of alpine and subalpine meadows and cushion-shrublands, in the Bamyán area descending also into chenopodiaceous dwarf-shrub semi-deserts; from 2500-4200 m.

AFGHANISTAN. Ghorat: uppermost Lal valley at road to Panjaw, 2950 m, *P.* 19083; Bamyán: Band-e-Amir, *V.* 2761; 2800-2900 m, *R.* 18239; Darrah Kalu, 2600 m, *W.* 9804; Koh-e-Baba, Sard Darra, 4000 m, *Gilli* 427b. Kabul: Paghman mts., 2750 m, *Gilli* 421. Maydan: Unai pass, 3150 m, *Gilli* 425, *Neub.* 528; Seperlo Buli, SE Dasht-e-Nawur, 3850 m, *F.* 1506.

The species is easily recognized by the type and distribution of lemma indumentum: very dense, botuliform hairs at the apex only. In other morphological respects and in ecology it closely resembles *P. laterale*, and both species often grow together. Records of *P. barbellatum* from S Iran by Roshevitz (1951) and Bor (1970) are erroneous. The cited specimen Bornm. 4844 belongs to *P. molinioides* (see sp. no. 12).

Mez (1921) based his description on not clearly specified Afghanistan material of Griffith which was destroyed at Berlin. Bor (1970) cited as the type *Griff.* 6583. As I could not find that specimen (in W) and Bor does not specify it as the lectotype, I have chosen *Griff.* (Journ. Nr.) 997 as the lectotype.

**16. *P. laterale* (Regel) Roshev. in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 14:117 (1951).**

In dense tufts, with some generative and numerous vegetative shoots, branching intravaginal; culms (12-)25-50(-80) cm, (2-)3(-4)-noded, glabrous; sheaths glabrous, rarely scaberulous; ligules at the culm leaves (2-)3-5(-7) mm long, obtuse or acute, often lacerated, at the vegetative shoots (1.5-)2-4(-7) mm long, alike; blades greyish green, flat or involute, at the culm leaves up to 7(-15) cm  $\times$  (1.0-)1.5-2(-3) mm, at the vegetative shoots up to 15(-20) cm  $\times$  1.0-2(-2.5) mm, upper surface pilose to pubescent, rarely almost glabrous, beneath usually scaberulous grading into scabrous towards the apex, rarely glabrous or pilose; panicle usually contracted, but occasionally laxer, (4-)7-12(-17) cm long, (0.5-)1-2(-3) cm wide, the branches erect or ascending, solitary or paired, rarely in whorls of 3-5(-7), scabrous or glabrous, the longest about  $\frac{1}{3}$  of panicle, never reaching  $\frac{1}{2}$ ; spikelets lanceolate, (5-)6-9(-10) mm long, glumes variegated with a pale green back and purple tip, or with purple tip and margins, or pale throughout with or without a yellow rim, lower glume usually 7-nerved, upper glume 5-nerved; lemma at mature fruit narrow lanceolate to almost linear, (3.2-)4-6(-6.5)  $\times$  0.8-1.3(-1.5) mm, covered all over by 0.2-0.3(-0.4) mm long white, stiff, ascending hairs, scar transversely linear; awn (1.5-)2.5-4.5(-6) mm long, up to 2(-4) mm exserted, terminal, straight, caducous or subsistent; lodicules 0.9-1.1 mm long, the lower ones ovate, the upper lanceolate to linear; anthers 2-3.5(-3.8) mm long, yellow or purple-tinged, usually bearded; caryopsis narrow ellipsoid to cylindric, slightly compressed, (3.0-)3.5-4.1  $\times$  1-1.2 mm, ratio embr.:car. = 1:4, hilum almost reaching the top (fig. 3p).

From E Anatolia through Iran and Afghanistan to Baluchistan and the C Hindukush in Pakistan, to the NE through the Pamir Alai and Pamirs up to the Tianshan; covering all high mountain-areas of the Irano-Turanian region (fig. 14).

A very common species in many different communities of the subalpine and alpine regions, especially in cushion-shrublands, more rarely descending into open woodlands; from (2500-)2800-4000(-4350) m.

- 1a. Panicle with the lower branches in whorls of 3-7; awn persistent to subsistent . . . . . b, subsp. *verticillatum*
- b. Panicle with the lower branches solitary or paired; awn caducous . . . . . 2

- 2a. Spikelets loosely arranged; lemma 4.2–6 mm long; anthers 2–3.5 mm long . . . . . a, subsp. *laterale*  
 b. Spikelets densely arranged, panicle therefore somewhat spikelike; lemma 3.2–4.4 mm long; anthers 1.5–1.7 mm long . . . . . c, subsp. *alpestre*

**a. subsp. *laterale***

Syn.: *Milium laterale* [Munro ex] Regel in Trudy Imp. S.-Petersburgsk. Bot. Sada 7:645 (1880). The nomen "*Piptatherum laterale* Munro in herb. Griff." (Journ. Linn. Soc. Bot. 18:106, 1880) refers.

*Oryzopsis pubiflora* Hack. in Stapf, Denkschr. Akad. Wiss. Wien, Math.-nat. Kl. 50:8 (1885). Type: Persia, in monte Elwend, in rupestribus supra Tusirkan, 1882, *Pichler* (holo. WU!; iso. K!, LE!, B!, Z!).

*O. molinioides* Boiss. var. *pubiflora* (Hack.) Bornm. in Beih. Bot. Centralbl. 33:215 (1915).

*O. vavilovii* Roshev. in Trudy Prikl. Bot. 19:123 (1928). Type: Afghanistan [Nuristan, S side of Porun pass], 3500–4000 m, 20 x 1924, *Vavilov* s.n. (LE—non vidi).

*O. sogdiana* Grig. in Trudy Tadzhik. Baz. Akad. Nauk SSSR 8:576 (1938). Type: USSR [Hissar range, northern slopes, E slopes of Uch-sada, basin of river Jagnob] 3000 m, 5 viii 1934, *Grigoriev* 174 (holo. LE!).

*Piptatherum fedtschenkoi* Roshev. in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 11:116 (1949). Type: USSR. Tadzhikistan [Varsob valley 1.5 km below Gushari], 9 vii 1933, *Fedtschenko* & *Czernova* 22 (holo. LE!).

*P. pubiflorum* (Hack.) Roshev., l.c. 14:111 (1951).

*P. vavilovii* (Roshev.) Roshev., l.c. 14:118 (1951).

*P. sogdianum* (Grig.) Roshev., l.c. 14:118 (1951).

Type. Afghanistan: Kurram valley, Sikaram, common at 3650 m, dry localities, ann. 1879, *Aitchison* (holo. LE; iso. K!).

TURKEY. Bitlis: Suphan Da., 3300 m, *Davis* 24756. Van: 36 km from Başkale to Hosap, Guzel Dare Pass, 2750 m, *Davis* 45980. Hakari: Samdi Da., 2800 m, *Rix* 236.

IRAQ. Arl Gird Dagh, 3000 m, *Guest & Husham* 15840; *ibid.*, Helgurd Range, *Ali Al-Rawi* 24803; *ibid.*, Helgurd, 3000–3800 m, *R.* 11429.

IRAN. Azerbaijan: Isperochan in m. Sahend, 4 viii 1884, *Knapp*. Kordestan: Kuh-e-Avroman a. Schahu, 6 vii 1867, *Hausskn.* Kuh-e-Dalakhani above Sungur, 3200 m, 6 ix 1867, *Hausskn.* Hamadan: Kuh-e-Elwand, 2700 m, *Pabot* 10069E. Luristan: Dowrud, 2600 m, *Koelz* 18377. Khuzestan-Fars: Kuh Nor, 3900–4200 m, vii 1868, *Hausskn.* Fars: Kuh-e-Daena, Secani pass, *Behboudi* 923E, 9037 E. Kerman: Kuh-e-Lalesar, 4000 m, *Bornm.* 4846; 4847. Mazandaran: Kandevar pass, 2800 m, *W.* 2078; Totschal, 3500–3800 m, *Bornm.* 8358. Tehran: at Derbent near Tehran, *Kotschy* 822. Semnan: Kuh-e-Nizwa, N Djaschm, 2200–2600 m, 1948, *Behboudi & Aellen.* Kuh Shahvar above Nekarman, 2700 m, *R.* 5989 p.p. Khorasan: Kuh-e-Bizg, 2200 m, *R.* 1457.

AFGHANISTAN. Bamyan: Shahtut pass, 2800–3000 m, *R.* 36377; Band-e-Amir, 3500 m, *Dieterle* 587; Koh-e-Baba, 3600 m, *K.* 2632. Parwan: Panjshir,

Darra Rastagal, 3200 m, *W.* 5226. Baghlan: N Salang, 3300-4100 m, *Furse* 8775. Maydan: Unai pass, 3000-3250 m, *R.* 18108. Kabul: Paghman mts. above Paghman, 3300 m, *W.* 4407. Ghazni: between Sariab and Dasht-e-Nawur, 3100 m, *R.* 37233. Urozgan: 35 km NE of Kundulan, 2650 m, *F.* 930. Logar: Shutur Gardan pass, 3250 m, *F.* 5754. Paktya: Altimur pass, 2850-3200 m, *R.* 21831 p.p., 32015. Kotgay, *V.* 62, 367, 495. Badakhshan: Qazi Deh, 3400 m, *Roemer* 128; Darya-e-Waghjir, 4100-4250 m, *A.* 7699. Wazit valley, 3800-4000 m, *A.* 8197.

PAKISTAN. Quetta: Urak valley, v 1958 *Repp.* Chitral: Baroghil pass, 4100 m, *Stainton* 2986. Swat: upper Swat, *Aslam Khan* 25220.

USSR. Tadzhikistan: Seravshan, Voru, 18 vii 1892, *Komarov*. Chovann, 2000 m, 15-27 vi 1897, *Lipsky*. Gorn. Seravshan, Dukdon above Sarytag, 2450 m, *Zaprzagajeva* 858. Jagnob valley, Hak pass, 3500-3600 m, *Fedtschenko* 796. Shugnan, Badam-darya, 29 vii 1904, *Fedtschenko*. NW Pamir, mouth of Tachta-Korum valley, 3800 m, 2 viii 1958, *Tolmatcheva*, *Tzvelev* 879 p.p.; Pamir, basin of W Pshart, 3750 m, *Tzvelev* 543.

**b. subsp. verticillatum** Freitag **subsp. nov.** Differt a subsp. *laterale* arista persistenti et ramis verticillatis, ramis verticillorum 3-7.

Type. Afghanistan. Yonutt [between Unai pass and upper Hilmand valley], sward of ravine, along water, *Griffith* 130 [Journ. no. 1017; Herb. East India Comp. 6582] (holo. K!; iso. W!, LE!).

AFGHANISTAN. Bamyán: Panjaw, 2700 m, *W.* 4884. Maydan: Farakulum, 2700 m, *K.* 2536. Ghazni: Diwal pass between Okak and Behzud, 2800 m, *R.* 17944; Qalai Beland, W of Ghazni, 2400 m, *A.* 4043; Dasht-e-Nawur, S side, 3100 m, *A.* 3942. Logar: W side of Altimur pass, 2600-2700 m, *R.* 31919.

The new subspecies is confined to C and E Afghanistan, usually at somewhat lower altitudes than *ssp. laterale*. The plants tend to be somewhat taller with longer panicles than in the typical subspecies.

An isotype of *P. laterale* in Leningrad (LE) has been called *P. vavilovii* by Roshevitz, and the relations between both names must be discussed. Roshevitz (1928) founded his *P. vavilovii* on two Afghan gatherings: *Vavilov* 20 x 1924 from the S side of the Porun pass in Nuristan, and *Bukinich* 28 viii 1924 from Farakulum in the upper Hilmand valley. Neither gathering has been seen. But in the description it is mentioned explicitly "arista caduca". Certainly the Nuristan material, which was collected far outside the area of subsp. *verticillatum*, has such caducous awns and therefore belongs to *P. laterale* subsp. *laterale* differing only in the somewhat larger size of the plant. Probably the Bukinich gathering from the area has persistent awns and belongs to our taxon (i.e. subsp. *verticillatum*), because later on Roshevitz (1951) changed his view and insisted on the persistent awn for *P. vavilovii*. For nomenclatural reasons the name *P. vavilovii* must remain attached to the Vavilov specimen and therefore be reduced to a synonym of *P. laterale*.

**c. subsp. alpestre** (Grig.) Freitag, **stat. nov.**

Syn.: *Oryzopsis alpestris* Grig. in Trudy Tadzhiik Baz. Akad. Nauk SSSR 8:579 (1938).



*Piptatherum alpestre* (Grig.) Roshev. in Bot. Mater. Gerb. Bot. Inst.

Komarova Akad. Nauk SSSR 14:120 (1951).

Type. USSR, C Asia: [Hissar mts., N side, in upper Jagnob valley], 3000 m, 16 viii 1934, Grigoriev 207 (holo. LE!).

AFGHANISTAN. Baghlan: N Salang pass, above tunnel, 3000-3500 m, *F.* 3513a; *ibid.*, 3000 m, *Neub.* 4488.

USSR. Tadzhikistan: Hissar mts., Ssu-baschi, source of river Khanaka, 2900 m, 3-15 vii 1896, *Lipsky*.

Because the type of *Oryzopsis alpestris* is close to *P. laterale* subsp. *laterale* (with lemmas of 3.8-4.4 mm in length) and the differences between them are not marked, this taxon should be considered at subspecific level.

The most difficult problem in dealing with *P. laterale* was its relation to *P. pubiflorum*. In putting together the huge number of measurements carried out on the vast amount of material now available from E Anatolia to the Pamirs I found it impossible to separate a more westerly *P. pubiflorum* from an easterly *P. laterale*, although the extremes and even the types look rather different (see table 10). According to the size of the plant it is true that in W

TABLE 10

Some characters measured in the type specimens of species included in *P. laterale*

	<i>P. pubiflorum</i>	<i>P. laterale</i>	<i>P. sogdianum</i>	<i>P. fedtschenkoi</i>
Size of plant, in cm	50-70	12-25	35-60	60-80
Colour of glumes	pale	variegated	pale	variegated
Length of lemmas, in mm	5.5-6.5	4.8-5.5	4.5-5.0	5.0-5.5
Length of awns, in mm	4-6	3	4-5	3.8

and SW Iran and in Turkey the plants tend to be taller, but otherwise the size much depends upon environmental factors, and even in the west dwarf plants have been collected, e.g. *Bornm.* 4846 (Kerman) up to 10 cm only, whereas in the east they may grow as high as 70 cm (e.g. *F.* 1515 from C Afghanistan). The spikelets are commonly pale in the west and variegated in the east, but with the other form always present in any region. The lemma in most of the western material is larger than in the eastern, but the range is about the same: 4.6-5 mm in SW Iran and 4-6 in E Afghanistan. Only the length of the awn differs more, with (2-)4-6 mm in Iran and (1.5-)3-4(-5) mm in Afghanistan. Furthermore, in the west sometimes a long lemma is combined with a short awn. Generally specimens with longer awns are found in areas where *P. holcifforme* is present at adjacent lower altitudes.

*P. sogdianum* and *P. fedtschenkoi* should also be included into the synonymy of *P. laterale*. As the data in tab. 10 indicate, they are within the range of *P. laterale*. I could not find any other essential difference. In the case of *P. fedtschenkoi*, Roshevitz (1949) gave emphasis to the long basal internodes, which, however, are evidently caused by environmental factors (see p.347). The species has been already included in *P. sogdianum* by Pazij (1968). The latter, according to its description, should have rather long awns of (5-)6-8(-10) mm, but in the type they are just 5 mm long.



17. *P. platyanthum* Nevski in Trudy Bot. Inst. Akad. Nauk SSSR, ser. 1, 4:336 (1937).

Syn.: *Oryzopsis platyantha* (Nevski) Grig. in Trudy Tadzhik. Baz. Akad. Nauk SSSR 8:578 (1938).

Type. USSR, C Asia: Kuh-i-Tang, supra pagum Chodsha-i-fil, inter lapides sub cacuminibus, 27 vi, *Nevski* 454 (LE—non vidi).

In small, dense tufts, with some generative and numerous vegetative shoots, branching intravaginal; culms (10-)20-50(-60) cm, (2-)3-noded, glabrous; sheaths glabrous to minutely pilose between the veins; ligules at the culm leaves (2-)3-5(-6) mm long, obtuse, often lacerated, at the vegetative shoots 1.5-3.5 mm long, blades flat or involute, at the culm leaves up to 8(-12) cm  $\times$  1.5-2.5(-4) mm, at the vegetative shoots up to 12(-15) cm  $\times$  1-2(-3) mm, greyish-green, upper surface minutely pilose, beneath almost glabrous grading into scaberulous towards the apex, or scaberulous throughout with a scabrous apex; panicle contracted, (3-)5-10 cm long, 1-1.5(-2) cm wide, the branches erect, paired or solitary, scabrous, the longest shorter than half of panicle; spikelets broad lanceolate, 7-10(-11) mm long, usually variegated, the glumes with a green back and broad purple margins and tip, more rarely only yellow-rimmed, both glumes 5-7-nerved; lemma at mature fruit ovate to elliptic, widest at the middle, (4-)4.5-5.5(-6)  $\times$  (1.3-)1.5-1.8(-2) mm wide, with a rounded apex, covered throughout with slightly ascending brownish hairs, near the apex with short spreading hairs, rarely in the lower half glabrescent or completely glabrous, scar transversely elliptic to linear; awn 2.5-4(-5) mm long, 0-1 mm exserted, almost terminal, straight, caducous; lodicules 1 mm long, the lower ones ovate, the upper linear; anthers 2-3 mm long, yellow or purplish, bearded or at least with 1-2 short apical hairs; caryopsis ellipsoid, dorsally slightly compressed, 3.5-4  $\times$  1.5 mm, ratio embr.:car. = 1:3, hilum almost reaching the top (fig. 4a).

From the Elburz in N Iran through the high mountains of Afghanistan to the Pamir Alai and Pamirs in USSR (fig. 18).

A typical, but rare component of alpine mats and cushion-shrublands, more rarely descending into the subalpine belt; from 2500-4550 m.

- |  |                            |
|--|----------------------------|
| 1a. Lemma hairy . . . . .              | a, var. <i>platyanthum</i> |
| b. Lemma completely glabrous . . . . . | b, var. <i>glabrum</i>     |

#### a. var. *platyanthum*

IRAN. Mazanderan: Nezva Kuh, near pass, 2800 m, *W.* 1225. Khale Zade Kuli, 3200 m, *Parsa* 177. Semnan: Shahvar above Nekarman, 2700 m, *R.* 5989 p.p.

AFGHANISTAN. Herat: Sabzak pass, S side, 2600 m, *Furse* 7704. Bamyān: Band-e-Amir, 2900 m, *A.* 4431; *ibid.*, 3000 m, *Dieterle* 964 p.p. Badakhshan (Wakhan): between Sargaz and Istmocho pass, 2930-4550 m, *A.* 7998: upper valley of Darya-e-Istmocho, 3900-4000 m, *A.* 8108.

USSR. Tadzhikistan: NW Pamir, mouth of river Tachta-Korum, *Tzvelev* 879 p.p.

b. var **glabrum** Freitag, var. nov. Differt lemmate omnino glabro. Differing from the typical variety in the completely glabrous lemmas.

Type. Iran: Mazanderan, Nezva Kuh by the pass to Chashm, 2800 m, 8 vii 1959, *Wendelbo* 1225 p.p. (holo. W!).

The new var. *glabrum* has been collected together with typical forms.

In the shape and indumentum of the lemma, *P. platyanthum* is somewhat intermediate between *P. purpurascens* and *P. laterale*. With the former it has in common the length-width ratio but the lemma is usually larger and the hairs in the apical region are strictly spreading whereas in *P. purpurascens* all the hairs are densely appressed. From *P. laterale* it differs in the much broader lemma with the widest circumference at or very close to the middle, the more rounded apex, and the larger spikelets. In some cases it has been collected together with *P. laterale* and mounted on the same sheets. Bor (1968, 1970) gave good illustrations of *P. platyanthum* under the name *O. molinioides*.

**18. *P. rechingeri* (Bor) Freitag, comb. nov.**

Syn.: *Oryzopsis rechingeri* Bor in Rech. f., Flora Iranica no. 70:402 (1970).

Type. Afghanistan: Ghazni, ad marginem orientalem altiplanitiei Dasht-e-Nawur, in arenosis mobilibus, 3000 m, 18 vii 1967, *Rechinger* 37277 holo. W!).

Densely tufted, with few generative and numerous vegetative shoots, with the bases 3–5 cm deep in the ground, branching intravaginal; culms 8–25 cm tall, geniculate, 2–3-noded, glabrous; sheaths of the culm leaves scaberulous, of the vegetative shoots glabrous and persistent, paper-like, white or purplish; ligules at the culm leaves 3–5 mm long, acute, usually lacerated, at the vegetative shoots up to 8 mm long, alike; blades grey, involute, at the culm leaves up to 3 cm × 1.2 mm, at the vegetative shoots up to 10(–20) cm × 1 mm, upper surface shortly pilose, beneath scaberulous, the margins scabrous; panicle lax or contracted, 3–5(–7) cm long, 1.5–3 cm wide, the branches ascending to spreading, solitary, paired, or in whorls up to 3, glabrous to scaberulous, the longest less than half of panicle; spikelets lanceolate, 6–8 mm long, the glumes pale with purple or yellow tips, 5–6-nerved; lemma at mature fruit narrow lanceolate to almost linear, 5.5–6 × 0.8–1.0 mm (without hairs!), covered all over by 1–2 mm long white, stiff, ascending hairs, scar transversely linear; awn 3.5 mm long, 2–3 mm exserted, terminal, straight, semipersistent; lodicules 1.1–1.3 mm long, the lower ones lanceolate, the upper linear; anthers 3.5 mm long, yellow, bearded; caryopsis cylindric, dorsally flattened, about 4 × 1 mm, ratio embr.:car. about 1:4, hilum almost reaching the top (fig. 4b).

Endemic to the Dasht-e-Nawur area in eastern C Afghanistan (fig. 9).

Rare in subalpine semi-desert on open sandy plains.

AFGHANISTAN. Ghazni: Dasht-e-Nawur, E border, desertic sandy plains, 3050 m, *F.* 1533 (collected together with the type).

The species is remarkable for its very long lemma hairs (resembling those of *Stipa calamagrostis*) and its geniculate culms. Evidently it is restricted to the small semi-desert area around the Dasht-e-Nawur in C Afghanistan, like *Fibigia compacta*, *Astragalus antheliophorus* and a few other species.

19. *P. gracile* Mez in Feddes Rep. 17:211 (1921).

Syn.: *Oryzopsis gracilis* (Mez) Pilger in Notizbl. Bot. Gart. Mus. Berlin 14: 346 (1939).

*O. brachyclada* Pilger, l.c. 345. Types: Kashmir, Nanga Parbat Gebiet, oberes Rakhiot-Tal, Ganalo-Gletscher, 4000 m, Troll 7774 (B—destroyed); Kashmir, Ladak, Stag, 3350 m, 17 viii 1931, Koelz 2612 (neo. K!—Bor, 1960—; isoneo. E!).

? *Piptatherum roshevitzianum* Tzvelev in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 20:414 (1960). Type: USSR, NW Pamir, in vallis fl. Kaindy prope Sujak-Mazar in decl. pratensistepposa, c. 3500 m, 16 viii 1958, Tzvelev 1392 (holo. LE—non vidi).

*Oryzopsis lateralis* auct.: Stapf in Hook., Fl. Brit. India 7:234 (1897).

*O. molinioides* auct.: Stewart in Brittonia 5:440 (1945).

Type. Tibet occ., 3900–4900 m, Thomson s.n. (lecto. W!; isolecto. K!).

In small, dense tufts, with some generative and numerous vegetative shoots, branching intravaginal; culms (10–)25–55(–70) cm, 2–3(–4)-noded, glabrous; sheaths glabrous to scaberulous, rarely scabrous; ligules at the culm leaves (2–)3–6(–10) mm long, truncate to acute, sometimes lacerated, at the vegetative shoots (1·5–)2–4(–5) mm long; blades flat or involute, filiform, greyish-green, at the culm leaves up to 6(–8) cm × (1·0–)1·2–2·0(–2·5) mm, at the vegetative shoots up to 12(–20) cm × (0·9–)1·0–1·5(–2·0) mm, the upper surface minutely pilose, rarely almost glabrous, beneath glabrous with a scaberulous apex or scaberulous with a scabrous apex; panicle usually contracted, (2–)6–14(–19) cm long, 0·5–2·0(–2·5) cm wide, the branches erect or erect ascending, the lower ones paired, rarely in whorls up to 4, glabrous or scabrous, the longest usually c. a third of panicle; spikelets lanceolate, (4·5–)5–6·5(–8·5) mm long, the glumes with a pale green back and hyaline to yellowish margins, the apex purple tinged, sometimes fading, lower glume 5–7-nerved, upper usually 5-nerved; lemma at mature fruit narrow lanceolate to almost linear, (3·0–)3·5–4·5(–5·3) × (0·5–)0·7–0·9(–1·0) mm, awn insertion laterally and ventrally exceeded by 2 very short rounded lobes, on the whole surface densely covered with slightly ascending white 0·4–0·5(–0·7) mm long hairs; scar transversely elliptic to linear; awn (3–)3·5–5(–6) mm long, (0–)1·5–3(–4) mm exserted, delicate, subterminal, at the base slightly curved outwards, caducous; lodicules 0·8 mm long, broad ovate to elliptic, the upper narrower; anthers 1·7–2·5 mm long, yellow, rarely purplish, with a dense apical tuft of hairs; caryopsis linear in outline, dorsally slightly flattened, 2·3 × 0·6–0·8 mm, ratio embr.:car. about 1:3, hilum almost reaching the top (fig. 4c).

From the Pamirs in Tadzhikistan, Afghanistan, Chitral in Pakistan through the inner ranges of the Himalayas to Nepal; also in Tibet (fig. 8).

Very common in alpine steppes and meadows, sometimes descending into the upper forest belt (conifer-forests); from (2500–) 3000–4000(–4700) m.

AFGHANISTAN. Badakhshan (Wakhan): Futur valley, 2700 m, Roemer 56; between Semestan-e-Baharak and Langar, 3300–3800 m, A. 7353.

PAKISTAN. Chitral: Yarkhun, 3200 m, Bowes-Lyon 919. Rosh Gol NE of Tirich Mir, 4000 m, Stainton 2817. Swat: above Ushu, 2900 m, Stew. & Rahmann 25378a, 25376. Gilgit: Nanga Parbat, Rama, 3600 m, Webster & Nasir 6459. Baltistan: Biafo glacier, 3440–4000 m, Hartmann 160, 161, 169;

Shagarthang 2900–3000 m, *Duthie* 12141. Satpur Nullah, 3000–3500 m, *Duthie* 12031. Shinga valley, 3000–3500 m, *Duthie* 11919.

INDIA. Kashmir: Dras valley, 3000–3500 m, *Duthie* 11745. Abring, Zanskar, 3700 m, *Koelz* 2977. Himachal Pradesh: Pangi, Chamba, Luj-forest, 3000 m, 11 vii 1899 *Duthie*. Kanawar [Kinnaur], above Lipa, 20 viii 1847, *Clarke*. Uttar Pradesh: Tehri-Garhwal, below Jangla in Ganges valley, *Duthie* 48a. NEPAL. Pura, Muktinath, 3900 m, *Stainton* 2087.

*P. gracile* looks somewhat intermediate between *P. laterale* and *P. hilariae*. From the former, it differs in the presence of two minute lemma lobes and therefore the subterminal position of the awn, which is also more or less curved outwards just above its insertion. Furthermore, the indumentum consists of much longer hairs.

From *P. hilariae* it is easily distinguished by the almost linear, never elliptic lemmas, the absence of a beak and the long, dense indumentum on the lemma up to the apex. Ecologically, in the area influenced by summer rains, it takes the place of *P. laterale* which is restricted to the summer-dry Irano-Turanian region.

Some confusion has arisen about the identity and specific limits of *P. gracile*. Stapf (in Hooker, 1897) gave an excellent description of the species but mistook it for *O. lateralis*. Mez (1921) based his description on material at Berlin (B) which was destroyed in World War II. An iso- or syntype at Vienna (W) has been selected as lectotype. In 1939, Pilger described *O. brachyclada* from Nanga Parbat but again the holotype was lost at Berlin; Bor (1960) designated *Koelz* 2612 (K) as the neotype but a duplicate of that gathering was identified by Pilger himself as *O. gracilis*. From its descriptions, *O. brachyclada* appears to differ from *P. gracile* only in the longer lemma (4.5–5.4 as against up to 4.5 mm), and indeed a part of *Koelz* 2612 with lemmas up to 5.4 mm in length agrees rather well with *O. brachyclada*. But the same also happens with a few individuals of the Thomson gatherings forming part of the syntype material. According to the data available today, these large-fruited specimens should be considered as the endpoint of normal variation, which with regard to lemma size in *P. gracile* is not greater than in such other species as *P. laterale* and *P. holciforme*. It should be mentioned too, that forms with longer lemmas are more difficult to separate from *P. laterale*. Also the identification of certain gatherings from the E Hindukush, where the areas of both species overlap, proved difficult.

Judging from its description *P. roshevitzianum* Tzevelev also fits well into the normal range of *P. gracile*. Geographically and ecologically it also agrees well, extending the area of *P. gracile* from the Afghan Pamirs a little to the northwest.

Records of *Oryzopsis brachyclada* and *O. gracile* from Afghanistan and N Iran in Bor (1970) are erroneous. The specimens cited belong to *P. laterale*.

20. *P. hilariae* Pazij in Bot. Mater. Gerb. Inst. Bot. Akad. Nauk Uzbeksk. SSSR 10:20 (1948).

Syn.: *P. binabium* Pazij in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 11:32 (1949). Type: USSR [W Pamir, around Korogh], Nazarenko s.n. (holo. LE—non vidi).

*P. schugnanicum* Roshev., *l.c.* 11:24 (1949). Type: USSR [W Pamir, between Pishik and Nishus on W exposed slopes at river Panj, in xerophytic shrubs], *Ovchinnikov & Afanassjev* 226 (holo. LE!).

*P. tremuloides* Ovch. & Chuk. in *Izv. Akad. Nauk Tadzhik. SSR, Otd. Estestv. Nauk* 10:58 (1955). Type: USSR [Shugnan, Peter I range, Garmo valley, upper Khingoy], (TAD—non vidi).

*Oryzopsis wendelboi* Bor in *Nytt Mag. Bot.* 1:16 (1952). Type: Pakistan, Chitral, Barum Gol, Shokor Shal, 3300 m, 14 vii 1950 *Wendelbo* s.n. (holo. K!; iso. O!).

*O. humilis* Bor in *Kew Bull.* 1951:445 (1952). Type: India, NW Himalaya, distr. Jaunsar, rocks N of Deoban, 1 vi 1897, *Duthie* 19850a (holo. K!).

Type. USSR, C Asia [W Pamir, near Korogh] (TAK—non vidi).

In small, dense tufts, with some generative and numerous vegetative shoots, branching intravaginal; culms (10–)30–50(–70) cm, 2(–3)-noded, glabrous; sheaths glabrous to scaberulous between the veins; ligules at the culm leaves (2–)3–5(–7) mm long, obtuse to acute, at the vegetative shoots 2–4 mm long; blades flat or involute, at the culm leaves up to 5(–16) cm  $\times$  (1.2–)1.5–3.5(–4.5) mm, at the vegetative shoots up to 20 (–31) cm  $\times$  1.5–4(–4.5) mm, greyish-green, the upper surface minutely pilose, rarely almost glabrous, beneath scaberulous with a scabrous apex or glabrous with a scaberulous apex; panicle lax or contracted, (3–)7–18(–30) cm long, (1–)2–7(–15) cm wide, the branches at anthesis spreading, later usually erect, solitary or the lower ones paired, glabrous to slightly scabrous, the longest less than half of panicle; spikelets lanceolate, (4–)5–7(–8) mm long, variegated or pale (when growing in forests), lower glume (5–)7–8-nerved, upper usually 5-nerved; lemma at mature fruit narrow ovate to elliptic, widest at the middle or just below, (2.6–)3–4(–4.2)  $\times$  0.9–1.3(–1.5) mm, the apex usually beak-like and the insertion of the awn exceeded by 2 distinct rounded lobes carrying a dense tuft of stiff, brownish hairs, otherwise loosely covered by slightly ascending white 0.2–0.3 mm long hairs, dorsally below the apex usually glabrous and the terminal tuft of hairs therefore very prominent, along the dorsal line often glabrescent, scar transversely elliptic to linear; awn (1.8–)2–3.5(–4) mm long, included or up to 2(–3) mm exerted, subterminal, at the base curved outwards, caducous; lodicules 0.8–1 mm long, ovate, the upper narrower; anthers (1.5–)2–2.5(–2.75) mm long, yellow or purplish, glabrous or with few short hairs, not distinctly bearded; caryopsis ellipsoid, dorsally slightly compressed, 1.9–2.4  $\times$  1.0–1.3 mm, ratio embr.: car. = 1:3, hilum almost reaching the top (fig. 4d).

From Paktya and Nuristan in E Afghanistan through Chitral to Murree in Pakistan and Kashmir, with exclaves in the W Pamir and in Waziristan (fig. 9).

A typical plant of the upper forest belt, centred in the *Cedrus*- and *Pinus wallichiana* area, growing in forests as well as in different seral communities; more rarely extending into *Pinus gerardiana* woodlands and *Juniperus squamata* thickets, in Tadzhikistan recorded from xerophytic shrublands; (2150–)2400–3400(–3600) m.

USSR. Tadzhikistan: Shugnan, Gunt valley, 2–9 vii 1901, *Fedtschenko* 2.

AFGHANISTAN. Kunar: Mum pass between Parun and Kantiwo valley



2200–2800 m, *Kerst.* 877a; Pashki, 2600 m, *Edelberg* 948. Nangarhar: Dar-e-Nur, 3300 m, *F.* 6041. Paktya: Kurram valley, *Aitch.* 328, 444, *R.* 32252, 32246, *V.* 32, 50; Wurzana, NE Urgun, *V.* 191.

PAKISTAN. Waziristan: *Stewart, J. L.* 482. Chitral: Rosh Gol NE of Tirich Mir, 3400 m, *Stainton* 2791. Swat: between Khwazakhela and Shangla, 1300–1900 m, *R.* 30627a. Hazara: Thandiani, NE Abbottabad, 2400–2600 m, *Burtt* 715, *Stew.* 27791. Poonch, Azad Kashmir: road to Bedori, 2900 m, *Stew.* 23922.

Morphologically the species is characterized by its outwardly curved awn and the beaked and bearded lemma apex. In *P. gracile*, which sometimes grows together with *P. hilariae*, the lemma lobes are much shorter, a beak is not present, and the denser indumentum of longer hairs covers the terminal tuft. *P. munroi*, which also comes in contact with *P. hilariae*, differs in the always lanceolate lemma without any apical lobe.

I have not seen the type of *P. hilariae*, but the type of *P. schugnanicum*, reduced to synonymy by Pazij himself, was studied. *P. binabium* and *P. tremuloides* were also included in synonymy by Pazij (1968) and there is no reason to doubt this. *Oryzopsis wendelboi* is in all respects identical with *P. hilariae* and was only described because of ignorance of the Soviet literature.

More difficult in the case of *O. humilis*. The type differs considerably from the Chitral, Nuristan and Pamir gatherings of *P. hilariae*, especially in its smaller size, contracted panicle and smaller lemmas (2.6–3.2 mm). But small-sized lemmas do occur sporadically throughout the whole area, and the differences between the smallest and largest lemmas in *P. hilariae* are by no means as wide as in certain other species. The small size of the plant probably results from grazing. In panicle structure the gap becomes less if the Murree and Paktya gatherings are included in the comparison.

A few plants from Nuristan and Swat look like hybrids with *P. munroi*. They have long spreading branches and the lemma-beak is indistinct, but they have the apical lobes and the typical short awns of *P. hilariae*.

### III C. SUBSECT. HIMALAYANA [ROSHEV. EX] FREITAG

*Piptatherum* sect. *Piptatherum* subsect. *Himalayana* Roshev. in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 14:122 (1951)—non rite publicatum. Lemmate ambitu elliptico usque obovato, apice obtuso, pilis dense adpressis tecto. Sp. typica: *P. purpurascens* (Hack.) Roshev.

Lemma elliptic to obovate in outline, with obtuse apex, covered with appressed hairs. Two species of alpine environments in the Pamir-Alai and high mountains of Afghanistan; closely allied on account of their lemma shape and indumentum and occupying a rather isolated position, but certainly highly derived.

21. *P. purpurascens* (Hack.) Roshev. in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 14:122 (1951).

Syn.: *Oryzopsis purpurascens* Hack. in Vidensk. Medd. dansk. naturh. Foren. 1903:164 (1903).

Type. USSR, C Asia: Pamir, prope lacus Jashil Kul, 3900 m, in decliv. septentrionalis vers., 29 vii 1898, *Paulsen* 994 (holo. C!).



Densely tufted, with numerous generative and vegetative shoots, branching intravaginal; culms (15-)25-50(-60) cm tall, usually 3-noded, glabrous; sheaths smooth or scaberulous; ligules at the culm leaves 3-5(-6) mm long, obtuse or acutish, at the vegetative shoots 2-4(-4.5) mm long; blades flat or involute, at the culm leaves up to 7(-10) cm  $\times$  1.5-2 mm, at the vegetative shoots up to 25 cm, greyish-green, upper surface minutely pilose, beneath grading from rather smooth near the base to scabrous towards the apex; panicle lax or contracted, 7-12 cm long, 2-6 cm wide, with rather few spikelets, the branches ascending to spreading, solitary, paired or in whorls to 3, scabrous, each one with 1-3 spikelets, the longest hardly half of panicle; spikelets broad lanceolate, (5.5-)6-8(-9)  $\times$  1.5-2 mm, glumes with purple margins and tips, the lower glume 9-, the upper 7-nerved; mature lemma ovate to elliptic, at its widest near the middle, (3.2-)3.5-4(-4.5)  $\times$  1.3-1.5 mm with an obtuse apex, densely covered throughout with very short white or golden, appressed hairs; awn 3-4 mm long, included or up to 1 mm exerted, terminal, straight, caducous; lodicules 1 mm long, the lower ones broad ovate, the upper narrower; anthers 2-2.5 mm long, yellow, bearded; caryopsis ellipsoid, dorsally compressed, 2.4-2.6  $\times$  1.0 mm wide, ratio embr.:car. = 1:3, hilum almost reaching the top (fig. 4e).

From high mountains in C Afghanistan to the Pamirs in USSR (fig. 12). An important component of cushion-shrublands and alpine mats from 3000-4500 m, generally in drier areas than the related *P. pamiralaicum*.

AFGHANISTAN. Bamyān: Koh-e-Baba, Fuladi, 4250 m, *Br. A.* 1541. Maydan: S of Unai pass, 3900-4200 m, *Furse* 8593. Ghazni: Seperlo Buli SE of Dasht-e-Nawur, 3200-4200 m, *R.* 37355. Kabul: Paghman mts., 3500 m, *F.* 3565. Parwan: Panjshir valley, Darra-e-Rastagal above Mukeni, 3800 m, *W.* 5175. Baghlan: N Salang, 3300 m, *R.* 37496. Badakhshan: C Hindukush, Darra-e-Parshui, 3750 m, *Frey* 280; Qazideh glacier, N side of Noshag, 4350 m, *Aichhorn* in *F.* 7019; Darya-e-Istmochn, 4000 m, *A.* 8035.

The species is best characterized by the few-flowered panicle and the broad, ovate to elliptic lemma with a rounded apex and densely appressed short hairs.

**22. *P. pamiralaicum*** (Grig.) Roshev. in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 14:123 (1951).

Syn.: *Oryzopsis pamiraltica* Grig. in Trudy Tadzhiik. Baž. Akad. Nauk SSSR 8:582 (1938).

Type. USSR, C Asia [Hissar mts., northern slopes, Kumarkh valley, basin of river Tagob, *Cousinia franchetii* steppe], 2 viii 1934, *Grigoriev* 169 (holo. LE!).

In small, dense tufts, with few generative and numerous vegetative shoots, branching intravaginal; culms (10-)25-50(-60) cm tall; leaf characters as in *P. purpurascens* (see sp. no. 21); panicle lax or contracted, (4-)6-12 cm long, 1.5-6 cm wide, with rather few spikelets, the branches ascending to spreading or erect-ascending (in fruit), paired or solitary, scabrous, each one with 1-4(-5) spikelets, the longest scarcely half of panicle; spikelets ovate, 5-6  $\times$  1.5-1.8 mm, glumes with a green base and broad purple margins and tip, the lower 7-, the upper 5-nerved; mature lemma obovate elliptic, at its

widest just above the middle,  $2.5-3.5 \times 1.4-2$  mm, with an obtuse apex, densely covered with very short white or golden, appressed hairs; awn 3-4 mm long, 0.5-2 mm exerted, terminal, caducous; lodicules 0.7-0.9 mm long, the lower ones ovate, the upper lanceolate to obovate, slightly bifid at the apex; anthers about 1.5 mm long, bearded; caryopsis obovoid, dorsally compressed,  $2.2-2 \times 1.3-1.4$  mm, ratio embr.:car. = 1:2-2.5, hilum almost reaching the top (fig. 4f).

From central Hindukush in Afghanistan to the Pamirs and Pamir-Alai in Soviet Central Asia (fig. 11).

Very typical plant of low cushion-shrublands and alpine mats above 3300 m; in Afghanistan rarer than *P. purpurascens*.

AFGHANISTAN. Baghlan: N Salang, above tunnel, 3400-3500 m, *F.* 3513. Badakhshan: Noshag, at Qazi Deh glacier, 4350 m, *Aichhorn* 43 in *Br. A* 3820. Upper Baroghil valley at Baroghil pass, 3300-3800 m, *A.* 7899. Darya-e-Istmoeh, 4000-4200 m, *A.* 8059, 8099.

This high-alpine species is very closely related to *P. purpurascens*. Differential characters are the length of the spikelets and lemmas (with some overlapping!) and the shape of the mature lemma. It is clearly obovate and hump-backed in *P. pamiralaicum*, but more ovate with a gradual increase of thickness at the back in *P. purpurascens*.

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